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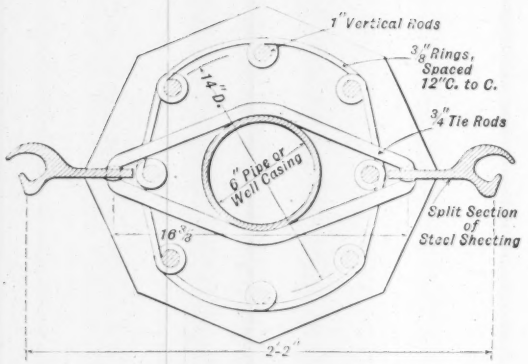
A Concrete Anchor Pile For Lackawanna Steel Sheet Piling

A new coal pier at Sandusky, Ohio, built by the Pennsylvania Lines for loading coal into vessels, has its concrete wall supported partly upon timber cribs and partly upon concrete piles in a single line of steel sheeting. This sheeting is composed of interlocking piles, and as the depth of loose material over the rock is very slight, special reinforced-concrete anchor piles are used to hold the sheeting in place as well as to carry the vertical load.



A type of anchor pile, designed and constructed for this work by the Great Lakes Dredge & Dock Co. of Chicago is shown in section in the diagram.

This anchor pile is octagonal in plan, 18-in. diameter, reinforced by eight 1-in. vertical rods which are hooped at intervals of 12 in., the hoops being looped around each rod. At two opposite corners are inserted the two halves of a split Lackawanna Steel Sheet Pile, the stems being held together by $\frac{3}{4}$-in. bent tie-rods. The steel sheeting engages with the projecting portions of the steel pile. In the center of the pile is a 6-in. pipe, and when the pile was in place a drill was dropped through it and a hole drilled into the rock. An old car axle was then dropped into the hole and grouted into the rock and the pile, thus anchoring the piling securely.

In the construction of the dock the anchor piles are spaced 8 ft. 9 in. center to center, and at the center of each panel of steel sheeting is a horizontal anchor rod attached to the top of the sheeting and anchoring it to a concrete beam on the opposite side of the pier. Each of these anchors consists of a pair of 2-in. rods secured by washer plates to old rails at either end, and the rods are incased in concrete for their entire length.

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Engineering News

VOLUME 76 OCTOBER 12, 1916 NUMBER 15

Garbage and Rubbish Disposal in Los Angeles, Calif.

By Seward C. Simons*

SYNOPSIS—Instead of paying out money for garbage disposal, Los Angeles receives 51c. a ton for all garbage delivered to a Cobwell reduction plant, owned by a company. The company collects and reduces dead animals, charging the owners for the service and turning over to the city a large part of the fees. Combustible rubbish is collected by private contractors, delivered by them to the garbage contractor, who sorts it, sells recovered matter and burns the tailings for plant fuel. Non-combustible refuse is placed on dumps.

Completing its first year of full-scale operation, the garbage-disposal plant of the Pacific Reduction Co., in Los Angeles, Calif., has justified the predictions that it would be the most successful undertaking of its kind in the country. The system employed is essentially the Cobwell method. Following the good results in Los Angeles and at the Panama-Pacific Exposition in San Francisco, it is being adopted in other places, having been specified in the recent contract in the City of New York.

Los Angeles has a population of about 550,000, but the garbage from the extreme southern portion of the city, with a population of about 50,000, does not go to the reduction plant. In October, 1913, a contract was entered into with the Pacific Reduction Co. to handle all of the city garbage for a period of ten years, the company agreeing to pay the city 51c. a ton for all garbage delivered to it. While the plant actually started operation in April, 1915, it was not until about July 1 of that year that it handled garbage up to its full capacity. Prior to the operation of this plant the garbage was fed to hogs on ranches maintained about 15 mi. from the city, and it was as a result of complaints as to this method that the city was forced into taking other means for disposal.

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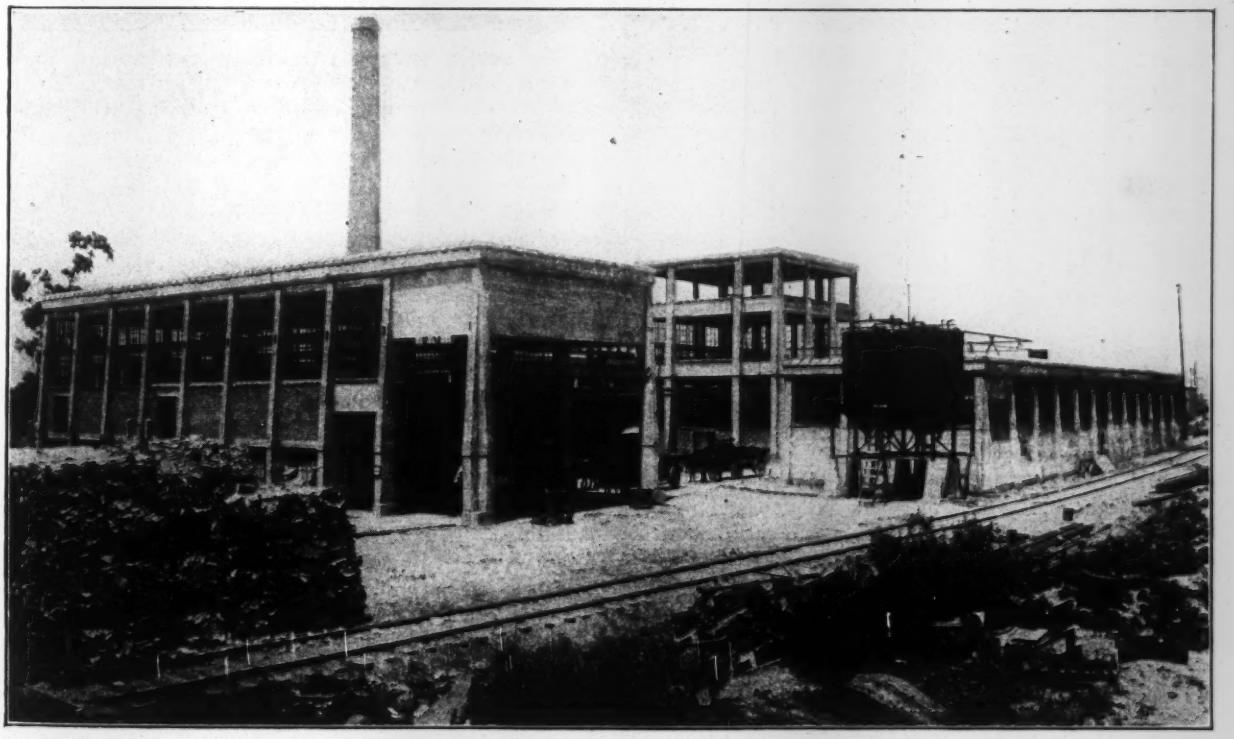


FIG. 1. GENERAL VIEW OF LOS ANGELES GARBAGE-REDUCTION WORKS
On the left, green garbage building in front and reducer building back of it (mostly out of sight); in center, condenser building; on right, four grease storage tanks, with office and warehouse extending back of tanks alongside the track

Figures just given out by the city engineer show the following amounts of garbage collected and delivered to the company during the past year:

LOS ANGELES GARBAGE COLLECTIONS AND DELIVERIES IN TONS, 1915-16

1915	Collected	Delivered to Company, Gross
July	11,707.2	2,495.2
August		3,364.2
September	5,510.8	3,161.3
October	4,764.0	3,086.2
November	4,296.4	2,848.1
December	4,173.3	3,315.0
1916		
January	4,279.3	4,290.3
February	4,230.0	4,229.9
March	4,520.6	4,520.6
April	3,975.1	3,975.1
May	3,812.3	3,812.3
June, estimated	4,500.0	4,500.0
Total	55,769.0	44,098.4

This indicates that since Jan. 1, 1916, all the garbage of the city has been taken care of at the plant, the month of June showing about 145 tons a day.

The disposal plant is located in the extreme southeast portion of the city on a site reached by the Atchison, Topeka & Santa Fe and the Salt Lake railroads. Over 5½ acres of ground have been provided, a part of it being used by the city for stables to house the collecting equipment. One objectionable feature in connection with the location is the long haul which is necessitated for the greater part of the city garbage, amounting to as much as 9 mi. at a maximum. No unpleasant odors emanate during the process, although in the vicinity of the garbage plant there is conducted a private tallow refinery, which at times pollutes the atmosphere very objectionably.

The buildings are uniformly of concrete and brick construction, with steel window frames. The stack is

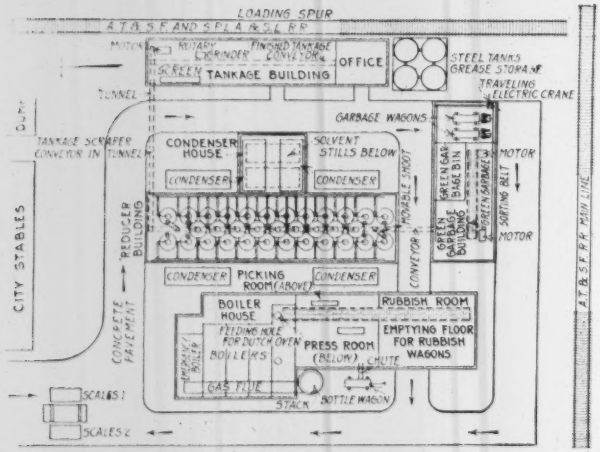


FIG. 2. GENERAL LAYOUT OF PLANT OF PACIFIC REDUCTION CO., LOS ANGELES, CALIF., LOOKING SOUTHEAST
Specially prepared for this article by the author

156 ft. high, and is said to be the tallest concrete stack in southern California. Fig. 1 is a general view of the plant and Fig. 2 shows its layout.

All the classes of city waste are handled in one manner or another at this plant. The refuse is divided into (1) garbage which is collected by the city, (2) combustible refuse which is collected by private contractors, but delivered to this plant; (3) noncombustible rubbish, which is collected by the city and deposited upon various dumps, a large one being located at this plant; and (4) dead animals collected and disposed of by the Reduction company. Los Angeles does not have to contend with the ash problem to any extent, since oil and gas fuel is generally used throughout the city.

About forty wagons, each having a removable steel body 13 ft. 6 in. long, 3 ft. 5 in. wide, and 2 ft. 6 in. high, with a holding capacity of from 3,800 to 4,500 lb. of garbage net, are used by the city in the garbage collection, requiring a force of 86 employees. During last year there were added two 2½-ton motor trucks, with similar movable bodies, which collect the garbage in the more remote districts. The general type of wagon is well shown in Figs. 1 and 3. The full wagon is weighed upon the scales (Fig. 2), then driven to the green-garbage building where the body is picked up by a traveling crane (Fig. 3), carried to a dumping bin, automatically emptied, washed and returned to the running gear, the whole operation

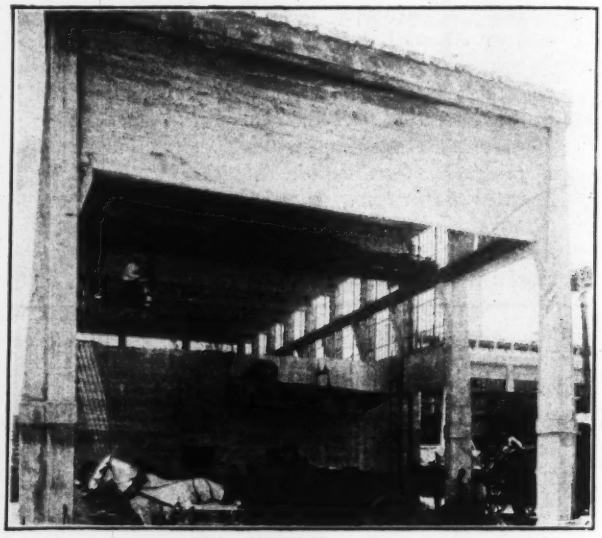


FIG. 3. HOISTING GARBAGE-WAGON BOX

taking about four minutes. From the large receiving bin the garbage is raked out onto a conveyor, during which operation tin cans, glass, etc., are removed by hand.

Dead animals are taken care of at the same plant, and are picked up by the crane and deposited in a separate portion of the same building as the green garbage. The Reduction company receives a fee of $3.50 from the owner for the collection of each full-size dead animal and $1.25 for calves, etc. The city receives a payment from the company of $3 for large animals and 80c. for smaller animals. The animals are skinned carefully, and then reduced exactly as is the garbage, although kept separate throughout.

From the conveyor in the green-garbage building the garbage is carried by a scraper conveyor into a general distributor running along the upper part of the reducer building. This building is 176x48 ft. in plan, and contains 32 reducers (Fig. 2). Since the photograph (Fig. 4) in the interior was taken, another row of nine reducers has been placed above the lower two rows, making a clear photograph of the interior practically impossible. Through the movable chutes shown the garbage can be fed into the various reducers from the conveyor.

The reducer is the central feature of the disposal process known as the Cobwell system, which was designed by C. O. Bartlett & Snow Co., of Cleveland. The apparatus consists of a steam-jacketed cylindrical steel

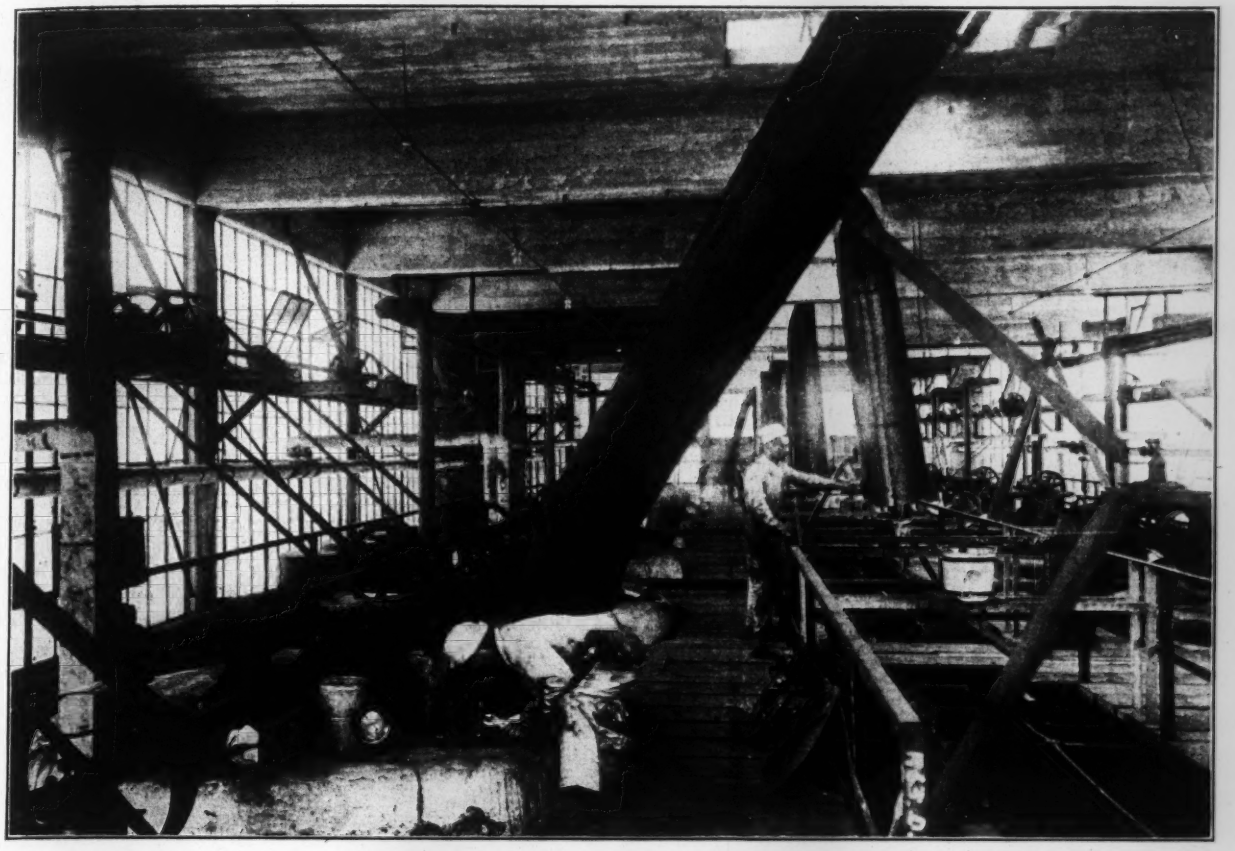


FIG. 4. CHARGING FLOOR OF REDUCER BUILDING, SHOWING FEED PIPES AND MOTOR DRIVES FOR ROTARY AGITATORS

Since the view was taken, nine reducers have been placed on this floor where the railing is shown

chamber, about 8 ft. in diameter by 4 ft. high. The interior is fitted with a rotating agitator actuated by gears (Fig. 4) driven by motors. From five to six tons of garbage are contained in each reducer per charge. Upon the placing of this amount within the apparatus a solvent known as cobolene, which closely resembles naphtha, is admitted in sufficient quantity to completely cover the garbage, after which steam at a pressure of about 90 lb. is admitted in the jacketed walls and bottom, and the agitating device is started. As the mass becomes heated the vapors containing both the solvent and evaporated water pass through a large vapor pipe line to a condenser where the solvent is separated from the water and returned to the reducer. The essential feature is that the water is vaporized at a lower temperature when evaporated along with a solvent having a low boiling point than otherwise. This part of the operation is continued until the solvent comes over to the condenser free from water. The garbage is then completely dehydrated.

The solvent at this point contains a large amount of grease which has been liberated from the garbage, and the mass of solvent and grease is then drained from the reducer to a still from which the grease can be recovered by evaporation of the solvent. The last trace of grease can be removed from the tankage by running more solvent through the mass and the residual solvent evaporated by additional heat so that very little loss is experienced. The tankage, free from grease and solvent, is automatically emptied from the reducers onto a conveyor. The whole operation consumes from 15 to 19 hr., depending upon the amount of water in the garbage and its general character.

From the reducer the tankage is conveyed to the warehouse where it is screened, ground and sacked (Fig. 5). In its final form the product is not dissimilar in appearance to unroasted ground coffee. About 630 lb. of tankage are produced from each ton of garbage, which shows a much larger yield than that usually found in other garbage-reduction processes.

An average analysis of the tankage shows: Nitrogen, 3.05%; phosphoric acid, 1.96; potash, 1.22; crude fiber, 16.55; carbohydrates, 45.75; grease, 1.71%.

Practically none of the tankage falls below 3% of ammonia. Naturally this product brings a good price upon the market for fertilizer purposes. The company today is receiving $14 a ton for its garbage tankage and about $55 a ton for dead-animal tankage. A considerable portion of the tankage is sold for stock feed. When soaked with water the tankage is highly nourishing, and is readily eaten by hogs and other stock.

Each ton of tankage also produces about 70 lb. of grease. That this is of high quality is proved by the fact that it is sold at from 5½c. to 6⅕c. per lb. in the local market as a soap ingredient. Under the terms of its contract the reduction company guarantees that the grease shall contain less than 10% free fatty acid, and in practice it runs below 7%. It contains 7% glycerin and less than 2% foreign solids and water.

The steam plant required consists of three 500-hp. boilers and one emergency boiler of 300 hp. It is estimated that about 660 lb. of steam are required to produce heat for one reducer charge. From 50 to 60% of the fuel required is furnished by waste rubbish and papers that are left over after a sorting process. The remaining fuel is furnished by crude oil.

In connection with the combustible rubbish it should be said that the company charges 60c. a ton to the private collectors who deliver the refuse to the plant for disposal. The refuse is thrown onto a wide steel belt and passes between rows of sorters where all useful substances are recovered. The tailings are fed into the furnace, as shown in Fig. 6.

By the terms of its contract, the city furnishes the necessary water for the condensing and cooling process. This naturally employs a large amount of water, but not more in proportion than is used in other reduction plants. Thus the water required per ton of garbage reduced at Los Angeles averages 1,700 cu.ft., compared with 2,300 at Boston and 2,600 at New York. As Los Angeles has a large amount of excess available water this is not a drain upon the city, although figured at cost the water probably amounts to more than $8,000 a year.

Through the operation of the plant the city has received an income of about $40,000 during the past year. Deducting the water expense, this amounts to a net income of about $32,000 from the garbage after collection. In spite of the longer haul the collection system has not proved more expensive than in previous years, chiefly because of the more perfect methods now in use. The city engineer's office gives the following average costs per ton for collection: Day collection wagons, $2.39; night collection, wagons, business district, $1.15; trucks, distant collection, $2.75; average (all forms), $1.87.

These figures take in all charges and expenses, including feed and care of stock, rentals and sundry supplies, maintenance, interest and depreciation of equipment and salary of superintendent.

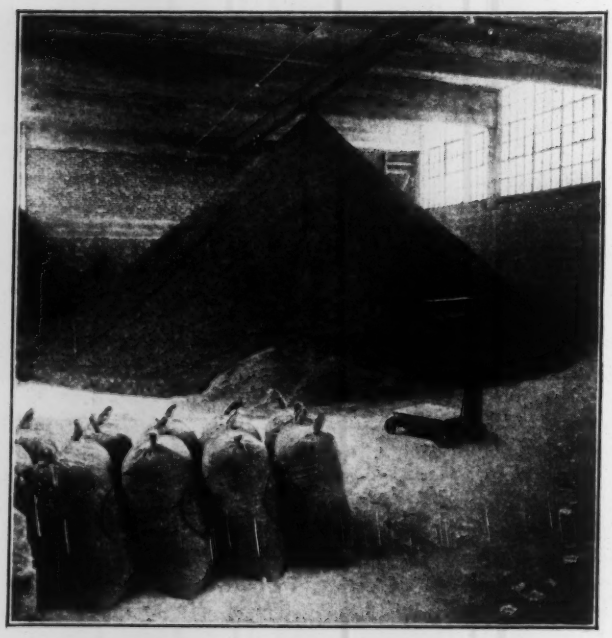


FIG. 5. GARBAGE TANKAGE BAGGED AND READY FOR BAGGING

FIG. 6. RUBBISH TAILINGS BEING FED TO FURNACE

It is difficult to estimate the profits made by the reduction company. Its initial investment was approximately $425,000. A total of 52 operators in three shifts a day are employed, in addition to which there is an administrative force, salesmen, etc. The chief engineer is H. A. Bighouse, while H. J. Murphy is treasurer.

Noncombustible rubbish is collected by the city in seven motor trucks. During the year nearly 48,000 cu.yd. have been collected at an average cost, according to the city engineer, of 94c. per cu.yd. This rubbish has been deposited in five dumps located in different sections of the city.

The Board of Public Works of the city and the city engineer express themselves as entirely satisfied with the operation of the plant. An explosion which, but for the fireproof character of the buildings, might have been serious, occurred in the reducer building in April. Except for the temporary disabling of the reducers, a comparatively small property loss was sustained. The plant suffered no ill effects. Without doubt the present method of disposal is highly preferable to the old hog-feeding plan. From a sanitary and æsthetic viewpoint, nothing further could be desired, while financially it is believed that Los Angeles has the most profitable arrangement of any city in the United States.

The Longest Water Conduit in the world is the famous Coolgardie line in West Australia, built in 1902. Water is pumped from a river in the humid coast region and is carried through 351 mi. of 30-in. lock-bar steel pipe to Kalgoorlie, in the West Australian gold field, in a district where rain seldom falls. The pumping engines which force the water through this main not only have to overcome the friction head but to raise the water a total height of 1,447 ft. At the time this pipe line was laid it was thoroughly protected with a mixture of coal tar and Trinidad asphaltum applied hot, but within a very few years after completion it was found that sections of the pipe were badly corroded. The annual report of the engineer of West Australia in charge of the Water-Supply, Sewerage and Drainage Department is reviewed in "The Engineer" (London) of Aug. 18 and gives interesting particulars regarding the further corrosion of this pipe line. The most serious corrosion has been due to the action of mineral salts in the soil of certain districts through which the line passes. The interior of the pipe, however, has become covered in many places with tubercles under which corrosion goes on. The increase in corrosion, from the figures in the report, appears to be rapid. In the year 1911-12 the number of holes occurring from external corrosion was only 124. In 1914-15 there were 2,078. In the first-named year £17,000 was expended on maintenance. In 1914-15 the expenditure was £51,000.

Building Foundations 150 Feet Under Scranton Armory

SYNOPSIS—A $300,000 building badly cracked by subsidence over old mine workings; old workings opened up and made accessible by 2-ft. bore hole in street; surveys made and masonry pillars built in old workings to prevent further settlement.

One of the buildings mentioned as seriously damaged by the subsidences over coal-mine workings in the City of Scranton, Penn., described in *Engineering News*, Aug. 10, 1916, is the 13th Regiment Armory, bounded by Myrtle St., Adams and Jefferson Ave. A corner of this $300,000 structure was illustrated.

For some months past, the work of putting foundations under this building has been in progress, although the structure itself is so badly damaged that it may eventually be largely rebuilt. This work involves some engineering features of an unusual character, including the development of a network of underground surveys from a base line established with two plumb bobs suspended only 17½ in. apart, as will be described farther on.

The armory building extends from Adams Ave. to Jefferson Ave. along Myrtle St., a distance of 325 ft., and has a width of 175 ft. on the avenues. The title to the land on which it is built came through the Lackawanna Iron and Coal Co. The building was erected chiefly by public subscription and by the city about 12 or 15 years ago, being subsequently taken over by the state.

The Lackawanna Iron and Coal Co. began mining operations in this vicinity in the fifties. The armory lot is on what was known as the Fairlawn or Lewis Jones tract, where the mining privilege was leased to the Fairlawn Coal Co., Ltd., in 1872. This company mined under a considerable part of the tract, particularly in the seam known as the Clark, which is the most worked seam in this immediate neighborhood. The Fairlawn Coal Co. sold out to the Lackawanna Iron and Coal Co. in 1891.

There are several seams of coal under the armory. The famous Big, or 14-ft., seam, also known as the G seam, outcrops near the armory on Adams Ave., but is not under the building. The uppermost worked seam below the surface at the armory site is the Clark, which runs 7 to 8 ft. thick and lies about 150 ft. below the surface. Under this are the three so-called Dunmore seams. The lowest of these, the No. 3, known as the China seam, is about 150 ft. below the Clark seam.

The accompanying map, Fig. 1, shows the condition in which the Clark seam was abandoned by the Fairlawn Coal Co., the dark portions being the pillars of coal left to support the 150 ft. of rock cover. This plan is based on actual surveys by J. H. Rittenhouse & Son, civil and

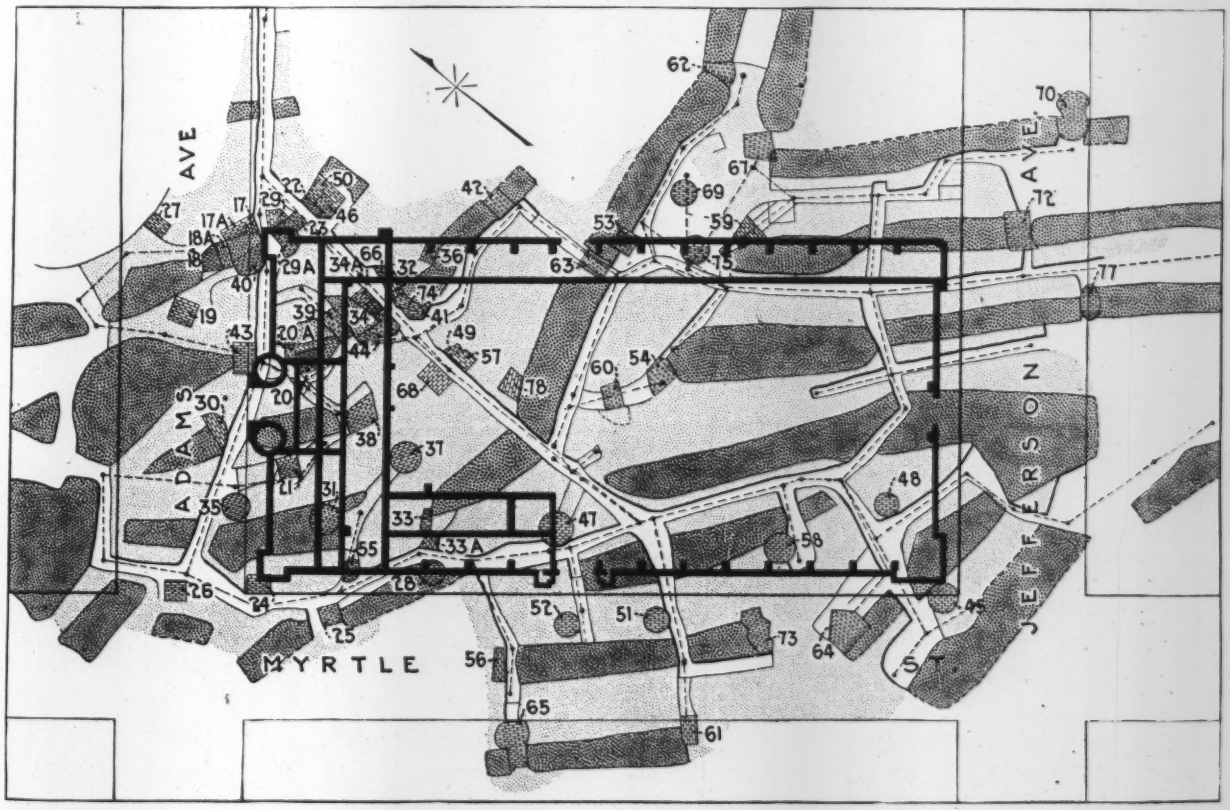


FIG. 1. PLAN OF CLARK COAL SEAM UNDER SCRANTON ARMORY, SHOWING PILLARS OF COAL AND MASONRY PILLARS WHICH HAVE BEEN ADDED TO SUPPORT THE ROOF

Dark portions are pillars of coal

mining engineers of Scranton, who have charge of both the engineering and the construction work on the armory foundations for the state. The condition of things in the No. 2 Dunmore seam, so far as present investigations indicate, appears to be about as bad. Survey lines have been extended under parts of the building by reopening old workings. In the other seams, which have been worked by more conservative methods of mining, there is little likelihood of squeezes or subsidences.

Effect of Subsidences on Armory

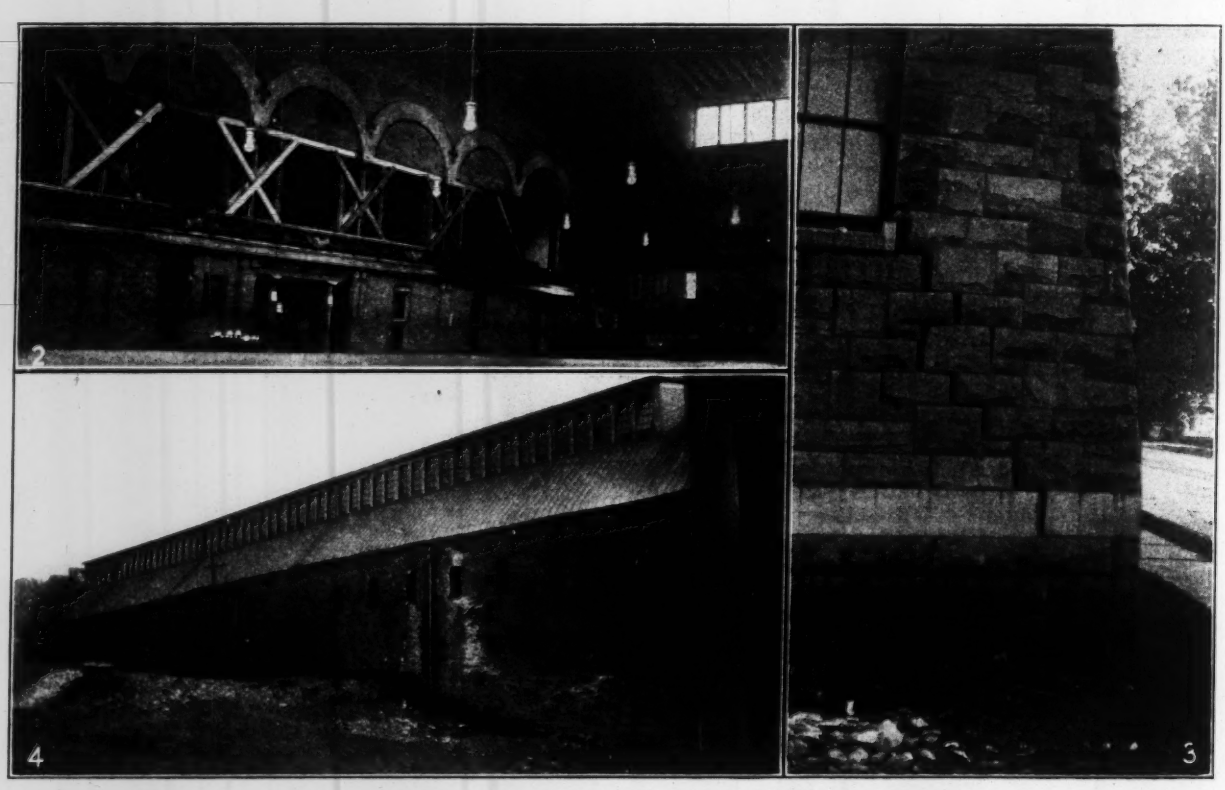
The armory is only one of several properties damaged by subsidences in this vicinity, which during the last few years have amounted all told to several feet. Levels taken on the drill-hall floor by Messrs. Rittenhouse showed that the end toward the front of the building has remained nearly level and that this condition continues 80 to 100 ft.; then there is a gradual inclination to the rear end, which is 2 ft. lower than the front. The dropping of the rear 2 ft. broke the side walls in several places.

The foundations of the armory are cracked and broken in many places. The swimming pool has cracks in the sides, and the doors of the lavatory adjoining cannot be closed, due to settling of the jambs and floors. The stone arch over the Myrtle St. entrance is broken, and part of it has slipped out of line an inch or more. The interior of the front of the armory containing the administration offices is badly damaged, great pieces of plastering having fallen off the ceilings and walls; the woodwork is warped, and this part of the building generally is in such condition as to be considered no longer safe for use. Much other damage, such as broken windows, tilted sills, iron girders pulled away from the roof and out of alignment, cracks and crevices in the floor and walls, etc., is ample evidence of the racked condition of the great structure.

The accompanying views, taken July 22, show some of the injuries to the armory. Fig. 2 is taken inside the drill hall, looking toward the spectators' gallery at the administration end of the building. One of the iron posts supporting the roof over this gallery has been broken squarely off, about halfway up. Needless to say, use of the gallery is not permitted. Fig. 3 shows the north corner tower (see plan, Fig. 1). The drill hall is still used, as the roof is supported by steel arches on piers independent of the walls, and there appears to be no immediate danger of collapse.

The current practice throughout the city and on the railroads of the valley is to reinforce the pillars of coal under important structures with concrete or masonry pillars or columns. This is generally done by use of the fallen roof rock found in the old workings. Walls of these stones (laid up in cement mortar) are built around the coal pillars and in places as crosswalls from pillar to pillar. The spaces between the pillars or walls are finally filled with loose rock or other material. The building of concrete piers under some of the bridge foundations of the Delaware, Lackawanna & Western R.R. at Scranton was described in *Engineering News*, Jan. 11, 1912, p. 60.

Messrs. Rittenhouse state that they have tried the method of building concrete retaining walls and filling back of them by flushing in culm or ashes, and that



FIGS. 2 TO 4. EXTERIOR AND INTERIOR VIEWS OF DRILL HALL AT SCRANTON, PENN.

Fig. 2—View of interior of drill hall of armory. Fig. 3—North tower, showing settlement cracks. Fig. 4—North wall, showing settlement cracks

FIG. 5. MINE CAGE FOR ASCENDING 24-IN. BORE HOLE

FIG. 6. MORTAR BUCKET AND TRAM CAR AT BOTTOM OF BORE HOLE

this method is not to be relied upon when all subsidence is to be prevented or guarded against. In such cases solid masonry pillars sufficient to carry the whole load are essential.

Method of Getting Under the Armory

The Clark seam immediately under the armory is inaccessible from any present mine working, except in a very roundabout way through old passages which had to be reopened. It was accordingly decided to get at the work by drilling a 24-in. hole in the street (Adams Ave.) about 200 ft. north of the armory. A 2-ft. bore hole was advisable rather than a larger shaft, because it was feared that blasting might start another squeeze (below ground) or subsidence. It was determined that timber, powder, mortar, etc., as well as the workmen could be lowered through a 24-in. bore hole.

The hole was accordingly drilled through the 150 ft. of solid rock cover, and it had the good fortune to end in one of the pillars of coal in the Clark seam, as was intended by the engineers. This prevented the end of the drill from punching through the roof of a chamber and probably blocking the bottom of the shaft with fallen débris from the roof. The bottom of the bore hole was reached through the old workings and the connection made.

The bore hole was remarkably straight, proof of which is that it was possible to suspend two plumb lines 17½ in. apart. This was the means of carrying the survey underground. It was found that with such a short base the ordinary plumb-line wires were out of the question, so a special method was developed of accurately prolonging the line. This is shown in Fig. 9.

The 15-lb. plumb bobs were suspended by ordinary iron stove-pipe wire, except for about 2 ft. above the bobs, where in one case a length of No. 6 jack chain was used and in the other case a section of No. 10 jack chain. The plumb bobs were of course immersed in buckets of water. The instrument was set up 15 ft. from the plumb lines; and as the bobs with the chains rotated, the opening in each link went through a complete circle. Since the two halves of each link were at right angles to

FIG. 7. CONDITIONS UNDER ARMORY AS THEY EXISTED

FIG. 8. LARGE CHAMBERS, SHOWING CRUMBLING PILLAR OF COAL ON LEFT

each other, when one opening changed to an ellipse, then to a narrow slit and finally vanished completely, the opening of the other link was changing from a narrow slit to the full opening.

A light was held behind the No. 10 chain so that the instrumentman could see its links through the links of the No. 6 chain. By catching the light through the narrowest slits of both chains simultaneously it was possible to line in the instrument with great accuracy. From this line prolonged, the underground traverse system shown by the dotted lines in Fig. 1 was established. Passageways under the armory were reopened, and about 70 masonry pillars were built, as shown in Fig. 1. These were placed to supplement so far as possible the remaining pillars of coal. The rock for these masonry pillars was gathered up from the old workings. The stones were laid up in cement mortar as tightly against the roof as possible, and judging from the present cracked condition of some of the stones in these columns they were not long in assuming a part of the roof load.

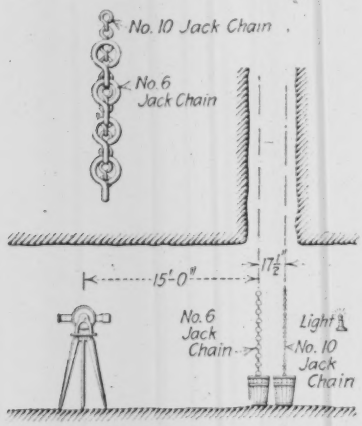


FIG. 9. SKETCH SHOWING METHOD OF SUSPENDING PLUMB BOBS

Taking the site of the armory as an independent unit, a cover of rock 150 ft. thick would exert a pressure of 22,500 lb. per sq.ft. If this pressure is concentrated on about 20% of the area, as is the case in these old workings under the armory, the unit pressure is five times as great, or 112,500 lb. per sq.ft. = 56.25 tons per sq.ft. The masonry pillars probably do not add more than 5% to the area, so that the pressure must still be in the neighborhood of 45 tons per sq.ft.

FIG. 10. GOB WALLS AROUND AND BETWEEN MASONRY PILLARS

The space between and around the masonry pillars is filled to the roof with hand-placed stone and débris—gob, as it is called—but this would not come into play as a column until some squeeze or settlement had occurred. All visible pillars have painted numbers, and the passageways are to be left open permanently, so that it will be possible to make inspections of the underground conditions.

Garbage Disposal for Two Illinois Cities

By Samuel A. Greeley*

Reports on refuse collection and disposal have been made by the writer to the two Illinois cities of Danville (35,000) and Galesburg (25,000) after investigations extending over several months. An act passed by the Illinois legislature in 1915 authorizes cities and villages with populations of less than 100,000 to establish and maintain plants for the collection and disposal of garbage and to levy a tax for the purpose not to exceed two mills on the dollar. This makes available in Danville about $18,000 per year and in Galesburg $14,000.

There are approximately 7,000 houses in Danville. Nine private scavengers collect garbage from some 200 customers, charging about 25c. per week. If this rate were applied to all the houses in the city, the annual cost would be over $80,000. The garbage is disposed of by dumping and by feeding to pigs. There are several dumps, and they are particularly unsightly on account of the tin cans and rubbish.

Night soil is removed by licensed private scavengers and is taken to a concrete dumping platform and emptied into the main sewer.

Disposal of Garbage and Refuse

After a careful analysis of local conditions and comparison with accurate records of refuse production in other cities it was estimated that the daily refuse production of Danville in 1920 would be: Garbage, 12.9; ashes, 32.4; rubbish, 6.5; tin cans, 2; manure, 12.5; total, 66.3 tons. Careful estimates were also made of the monthly and daily variations of refuse materials, as shown by Table 1.

Methods of refuse disposal were compared for each of the refuse materials and for mixed refuse. For garbage the methods of disposal considered were burial, feeding to pigs, incineration and reduction. Burial was recommended for the present, the estimated area of land required being 15 acres. With the growth of the city other methods would become advisable, as outlined later.

TABLE 1. MONTHLY PRODUCTION OF GARBAGE IN PERCENTAGE OF TOTAL ANNUAL PRODUCTION

Month	Columbus, Ohio	Dayton, Ohio	Fort Wayne, Ind., Estimated	Racine, Wis.	Danville, Ill., Estimated
January	6.28	6.58	6.20	5.56	6.10
February	5.67	6.82	6.00	5.12	5.90
March	6.36	7.45	6.70	6.22	6.50
April	6.70	7.05	6.70	6.54	6.90
May	7.78	7.20	7.40	7.23	7.40
June	7.82	8.18	8.30	9.22	8.40
July	9.40	10.21	10.10	10.89	10.00
August	12.24	10.74	11.20	11.29	11.20
September	12.95	11.08	12.00	12.29	12.40
October	9.20	8.94	9.40	9.04	9.20
November	7.83	8.10	8.10	8.35	8.10
December	7.77	7.62	7.90	7.65	7.90
	100.00	99.97	100.00	99.40	100.00

*Consulting Sanitary Engineer, 64 West Randolph St., Chicago, Ill.

A summary of the estimated costs of different methods of garbage disposal is given in Table 2. The annual costs are for 1920, with 4,000 tons of garbage for the year. These costs include land, scales, roadways, sewers, water connection, coal siding, etc. A rubbish-sorting

TABLE 2. SUMMARY OF ESTIMATES OF COST OF GARBAGE DISPOSAL AT DANVILLE, ILL.

Method of Disposal	Number of Plants	Capacity, Tons per 24 Hr.	First Cost, Complete	Annual Cost			Revenue	Net Annual Profit
				Operation	Fixed Charges	Total		
Burial	2	12.9	$19,180†	$2,600	$1,215	$3,815	None	....
Feeding to pigs	1	...*	44,000	7,300	2,819	10,119	$15,000	$4,881
Reduction..	1	36.0	63,250	7,540	5,060	12,500	21,600	None
Reduction..	1	24.0	45,000	7,540	3,375	10,915	12,600	1,685
Incineration	1	40.0‡	31,350	4,480	2,445	6,905	None	....

*Land sufficient for additional capacity; buildings easily added and pigs bred as required. †Includes land to last until 1920. ‡Includes capacity for rubbish.

plant was estimated to cost $9,020, and the gross revenue was estimated at $6,800 per year.

Refuse Collection

Special consideration was given to the collection service as a most important phase of the problem. A population spot map of the city was made, from which the wagon districts were determined. Where possible, each wagon was planned to make one trip per day. The number of wagons was then determined for each refuse material and for each method of disposal. Thus for disposal of garbage by burial two collections per week were assumed. The wagon capacities were planned for the maximum quantity of garbage. On the average each wagon was estimated to serve 200 houses per day, a total of 10 wagons being required. The first cost of wagons and equipment was estimated to be $3,850, and the annual cost $11,377.

For garbage disposal by feeding to pigs two collections per week were assumed for the fall, winter and spring and three collections per week during the three summer months. Owing to the longer haul, each wagon was estimated to serve an average of 167 houses per day. The cost of wagons and equipment was estimated at $5,600 and the annual cost at $14,850.

For the separate collections of rubbish a 10-day interval in collections was estimated. The wagon capacity was figured at 8 cu.yd. Two men were to work with each wagon, and the wagons were to make two trips per day. Three wagons were required for the service. Similar estimates of the collection service were made for other conditions.

Recommendations for Refuse Disposal

The recommendations resulting from the investigation were summarized as follows:

1. That an ordinance should be adopted establishing proper sanitary methods for the house treatment of refuse and the stable treatment of manure.

2. That 10 collection wagons be purchased at an estimated cost of $3,850. Specifications should be prepared and bids received.

3. That a permanent system for garbage collection should be established to give regular service twice a week. The wagons should be owned by the city, and the horses and collectors should be hired. Collectors should be required to wear khaki or duck uniforms.

4. That garbage be disposed of for the present by burial at two fields located on each side of the city. Five loads of garbage would be buried daily at each field. The estimated cost of weighing scales, roadways, etc., at the burial fields is $4,180. Garbage should be given to farmers who call for it in proper wagons at these fields, thus reducing the amount of garbage to be buried.

5. Proposals should be entertained for disposal of garbage by contract at some isolated location at an annual cost favorable to the city. Such arrangement should include a formal contract in which the character of plant and equipment is clearly defined to be of a type that can be operated on a sanitary basis. The contract, however, should not include collection.

6. A site with an area of about one acre should be purchased along the Chicago & Eastern Illinois Ry. at some location near the center of production of refuse. The site should be used for shipping tins and rubbish to the market. It should be reserved for a future incinerator, when disposal of garbage by burial or otherwise is no longer feasible, due to the increased population and scarcity of land for burial.

7. As the garbage-collection service becomes established, the collection of tins and rubbish should be started, and they should be shipped to the market for sale. After a site is secured, plans and specifications should be drawn up for a loading station for these materials.

The estimated first cost for the collection and disposal of garbage by burial is $9,000, and the annual cost of operation is estimated to be $14,300.

For garbage disposal by burial a trench is dug or ploughed about 3 ft. wide, 6 in. deep. Into this the garbage is dumped from the wagons and spread in a thin layer. A trench for the next day's garbage is dug and the excavation from this used to cover the garbage already spread. About 160 lin.ft. of trench would be required per day at each field for the average daily quantity of garbage of 12.9 tons.

For cold weather two methods are feasible. A sufficient length of trench to last through the winter may be opened before the frost sets in; or the garbage may be spread on the ground and covered with ashes and dirt, the mixture being ploughed into the soil during the spring. The preferable way is to plough enough furrows for garbage burial during the winter and to cover the garbage in the furrows with adjacent earth, ashes or street dirt. No decomposition takes place during the winter, and the covering can be trimmed and reinforced in the early spring.

The equipment should include a scale and scalehouse, with a room and stove for the operator and a place for washing the wagons. During the summer months garbage containing maggots should be soaked in a germicide. Sodium arsenate, creosote or other coal-tar derivatives can be used.

Somewhat similar recommendations were made for Galesburg, except that the work was limited to the collection and disposal of garbage. At Galesburg, options have been secured on burial fields, the rental to be about $100 per year. The council has passed the ordinance and has authorized the purchase of wagons. At Danville, negotiations for burial fields are still pending.

The Elephant Butte Dam on the Rio Grande River is to be formally dedicated on Oct. 14, at the time of the Irrigation Congress meeting. The dam has been built by the United States Reclamation Service. Its completion was recorded in "Engineering News" of May 18, p. 964. An official announcement of the dedication, issued by the Interior Department, states that the dam surpasses any dam ever before constructed in the volume of water stored behind it, as the reservoir when filled "will contain 856 billion gallons, enough water to cover the State of Delaware 2 ft. deep." The compiler of this announcement evidently forgot the Gatun Dam on the Panama Canal. According to the paper by F. D. Willson, Chief Hydrographer of the Panama Canal, at the International Engineering Congress, Gatun Lake, when its surface is 87 ft. above sea level, contains 1,442 billion gallons of water, which, it will be seen, is nearly twice as much as the capacity of the Elephant Butte reservoir. Both of these big bodies of water are modest lakes compared with the great reservoir behind the Assuan Dam on the River Nile, where, as stated in "Engineering News" of May 11, p. 906, the volume of water stored is over 20 times the volume of Gatun Lake.

Large Activated-Sludge Plant at Milwaukee, Wis.

SYNOPSIS—Layout, details of design and rates on operating experience of plant for treating part of the sewage of Milwaukee by aëration in the presence of activated sludge.

Luckily, just as the activated-sludge process of sewage treatment appeared on the American horizon, Milwaukee was in position to give it a thorough-going test at its sewage experiment station. From laboratory apparatus and fair-sized outdoor tanks of the fill-and-draw, and then of the continuous-flow type, the city went on to a 2,000,000-gal. continuous-flow unit, put in operation on Jan. 22, 1916. A description of this large unit follows.

Before describing the plant it may be noted that a factor in its design was the possible conversion of the activated-sludge tanks into digestion chambers for Imhoff tanks in case the new process does not prove to do all that there is reason to hope.

The activated-sludge plant is located on Jones Island, alongside a large outfall sewer of the combined system. It consists of eleven tanks. Eight of these are used in series for aëration of the sewage in the presence of activated sludge; one is a sedimentation tank and two are sludge-aëration tanks. Fig. 1 shows the layout of the plant. Figs. 2 to 5 give details of the various tanks. Of the three views, Figs. 6 and 8, shows the plant under construction, and Fig. 7 shows a group of filtros blocks or air

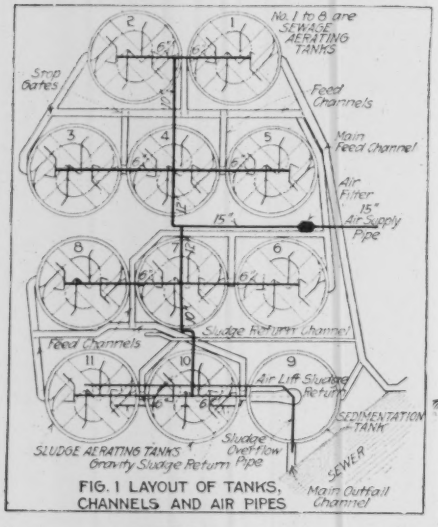
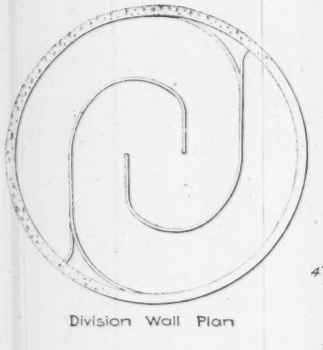


FIG. 1 LAYOUT OF TANKS, CHANNELS AND AIR PIPES



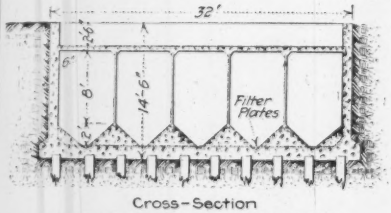


FIG. 2 SEWAGE-AERATING TANKS

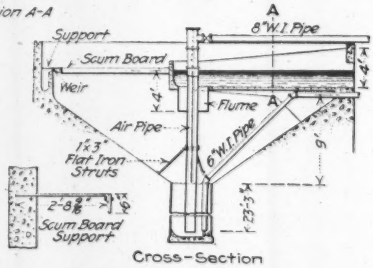
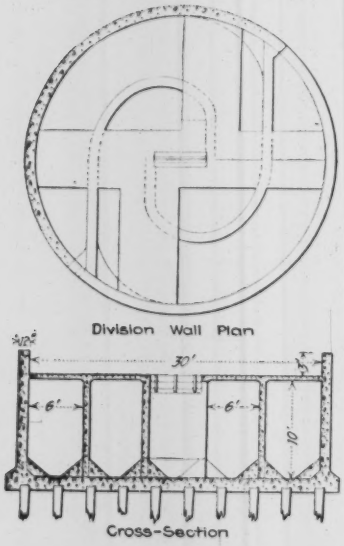
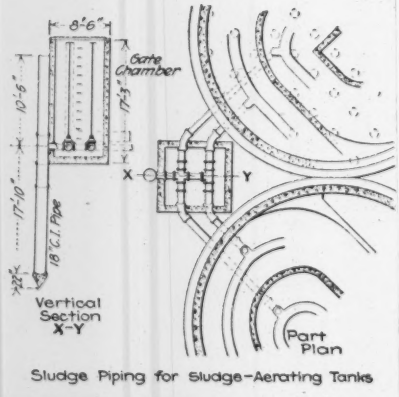


FIG. 3 SEDIMENTATION TANK





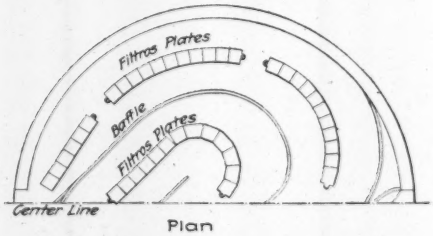


FIG. 4 SLUDGE-AERATING TANKS

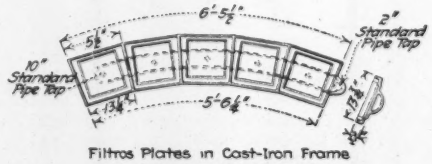
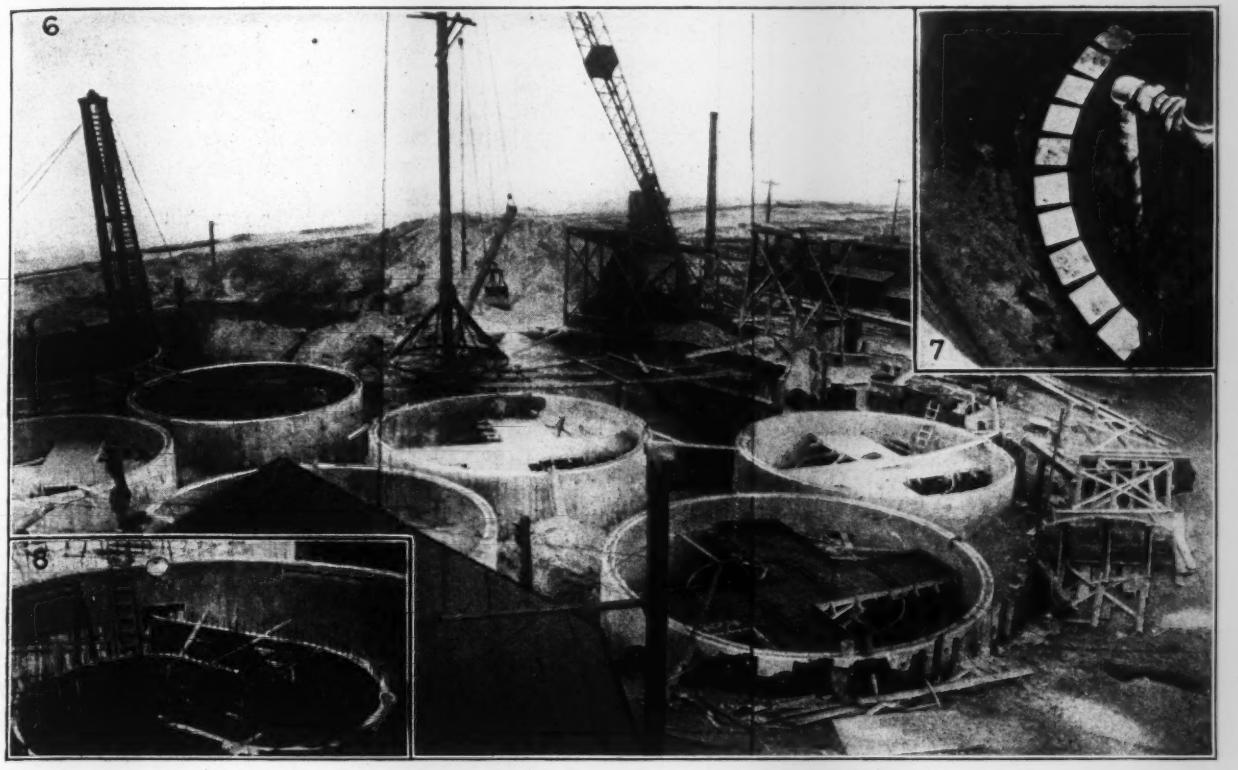


FIG. 5 AIR-DIFFUSER SYSTEM

FIGS. 1 TO 5. LAYOUT AND DETAILS OF 2,000,000-GAL. ACTIVATED-SLUDGE PLANT, MILWAUKEE, WIS.

Sewage and "seeded" sludge are aërated in tanks 1 to 8, the combined sewage and sludge passing on from one tank to another and then into sedimentation tank 9. From the bottom of a deep well in tank 9 the sludge is discharged by gravity into either sludge-aëration tank 10 or 11. The aërated sludge from these two tanks passes outside the tanks to a 48-in. vertical cast-iron pipe set 28¼ ft. in the ground, from which it is lifted by air and returned to the inlet to sewage-aërating tank 1



FIGS. 6 TO 8. CONSTRUCTION AND DETAIL VIEWS OF ACTIVATED-SLUDGE PLANT, MILWAUKEE, WIS.

Fig. 6—General view taken while plant was under construction, showing several tanks with platforms in place above tops of baffles. Fig. 8—Curved baffles to guide sewage flow in aërating tanks. Fig. 7—Looking down on a set of filtros air-diffusers in V-shaped bottom of curved portion of flowing-through chamber; showing air-supply pipe on the right

diffusers in place. The general scheme of operation is stated in descriptive note beneath Figs. 1 to 5 on the preceding page.

Each of the eleven tanks is built of reinforced concrete, has an internal diameter of 30 ft. and has side walls extending 13 ft. above its inner bottom. The total depth of sewage and sludge is 10 ft. and the average depth is 9 ft. in the ten tanks used for aëration. The sewage and sludge in the sedimentation tank is 35.2 ft. deep.

The holding capacity of each of the eight sewage-aërating tanks is 45,000 gal., or 360,000 for the group. The open area of each of these tanks is 662.84 sq.ft. and all of them, 5,303 sq.ft.

The sedimentation tank has a holding capacity of 33,000 gal., not including the 2,260 gal. held by the 48-in. cast-iron sludge pipe extending below its bottom.

Normal lake level is at El. —1.4. The sewage level in Tank 1 is at El. +0.8 and the weir in the sedimentation tank is at El. +0.5, giving a fall of 0.3 ft. in water level through the series of tanks.

By means of the curved baffle or division walls shown in the illustrations, the sewage travels and is subjected to aëration for a distance of 912 ft. Air diffusion is effected by means of 12x12-in. filtros plates, 78 to each sewage- and sludge-aëration tank. This gives a ratio of diffusing surface to tank surface of 1 to 8.5. The filtros plates are set in cast-iron frames, which afford an air-supply conduit beneath the center line of each plate. The estimated air capacity of the filtros plates in the eight sewage-aërating tanks is 2 cu.ft. per min., and in the two sludge-aërating tanks it is 12 cu.ft., in each case under a 2-in. water pressure.

Compressed air is supplied by a Connersville positive blower of the Boston type, with a capacity of 2,400 cu.ft. of free air per minute, compressed to 5 lb. per sq.in. This blower is belted to an alternating-current variable-speed motor of 75 hp. To prevent interruption in service this equipment is in duplicate. The two units cost $2,987, erected, including a frame house.

The volume and rate of air supply is measured by indicating recording integrating General Electric meters, there being one for the eight sewage tanks and another for the two sludge tanks. These meters cost $314 and $305, respectively.

The plant capacity under three different operating-rate schemes is as follows: (1) With 25% activated sludge in the aërating tanks, a 4-hr. running-through period, a velocity of 3.8 ft. per min., and a 27-min. sedimentation period, 1,620,000 gal. a day; (2) 25% activated sludge, 3-hr. running through, 5-ft. velocity and 20-min. sedimentation, 2,160,000 gal.; (3) with 20% activated sludge, 3-hr. running through, 5-ft. velocity and 19-min. sedimentation, 2,304,000 gal. capacity.

The plant has a total ground area of 0.347 acre, or 0.173 acre per 1,000,000 gal. capacity. The contract price for the eleven tanks, including 72 piles 40 ft. long under each tank and all piping, was $55,000. Adding the cost of the motors, blowers and air meters gives $58,606 as the total contract price of a 2,000,000-gal. activated-sludge plant under Milwaukee conditions. The final total estimate was $58,606. To this should be added $2,930 for engineering and inspection, making a grand total of $61,536 or $30,768 per 1,000,000 gal. The bonds bear 4½% interest and require a sinking fund of 5%.

The plant was built by the Milwaukee Sewerage Commission, of which George H. Benzenberg is chairman, T. Chalkley Hatton, chief engineer, and William R. Copeland, chemist and bacteriologist.

Results Obtained in Operation

The results of the operation of the Milwaukee activated-sludge plant through the first months of its service was summarized for *Engineering News* by Mr. Hatton on Aug. 15, 1916, as follows:

The plant went into operation on Jan. 22, 1916, and, with few interruptions, has been working under varied schedules up to the present time.

Early in the operation it became apparent that the sedimentation tank was not designed to properly meet the conditions, in that the velocity through the tank was too great and the bottom slope was too little. Instead of a 27-min. sedimentation period the indications are that about 60 min. will be required to permit the finer floc to settle out.

The settled sludge rested upon the sloping bottom to a considerable extent and, unless removed at frequent intervals by using a squeegee, became septic and consumed the dissolved oxygen contained in the influent. In addition to this, sludge accumulated in the 48-in. cast-iron pipe which was not removed by the air lifts, and this also became septic.

Instead of a 45° slope the bottom of the sedimentation tank should not be less than a 60° slope from the horizontal, and the sludge should be removed from a pipe built at the apex of the conical bottom so as to insure its constant and complete removal.

With the sedimentation tank as built it has not been possible to get more than 1,000,000 gal. of clear stable effluent per day through the plant without losing the sludge.

In order to try out horizontal-flow sedimentation, No. 11 tank has been improvised into three compartments, each of which can be operated separately. So far the indications are that an average horizontal velocity of 3 ft. per min. will be sufficient to secure satisfactory sedimentation, but this figure is subject to further determinations.

In operating the large plant throughout the last seven months several important matters have been fully demonstrated, among which may be mentioned: That an increase of air pressure is required due to the partial silting up of the top surface of the diffuser plates, which indicates that provision must be made to clean off these plates at intervals.

That when the temperature of the sewage is 50° F., or under, more air is required to produce an equal effluent from sewage having a temperature of 60° F. or over.

That circular tanks are not so efficient as rectangular tanks either in first cost or in operation and require much more area to treat an equal volume of sewage than do rectangular tanks.

That the mixed sewage and activated sludge must not be run through conduits as the tendency is for the sludge to settle out immediately in the conduits and become septic. The sedimentation tank must be connected to the aërating tanks without conduits.

That the settled sludge must be constantly and completely removed from the sedimentation tanks to prevent septic action.

Placing Foundations for Coke Plant Near New York

Work was started last April on the construction of a by-product coke plant on the Hackensack meadows, near Jersey City. The site of this plant, comprising about 35 acres, lies just north of the Delaware, Lackawanna & Western R.R. tracks on the west bank of the Hackensack River and just across the river from the power plant of the Public Service Co., of New Jersey. The gas manufactured in this byproduct coke plant will be piped by way of a tunnel under the Hackensack River to the gas holders of the Public Service Co., on the opposite bank. From there it will be pumped by means of a new pipe line to Newark and there distributed. This plant is being built by H. Koppers Co., of Pittsburgh, Penn., for the Seaboard Byproduct Coke Co., of New Jersey, and will consist of 110 Koppers byproduct coke ovens, together

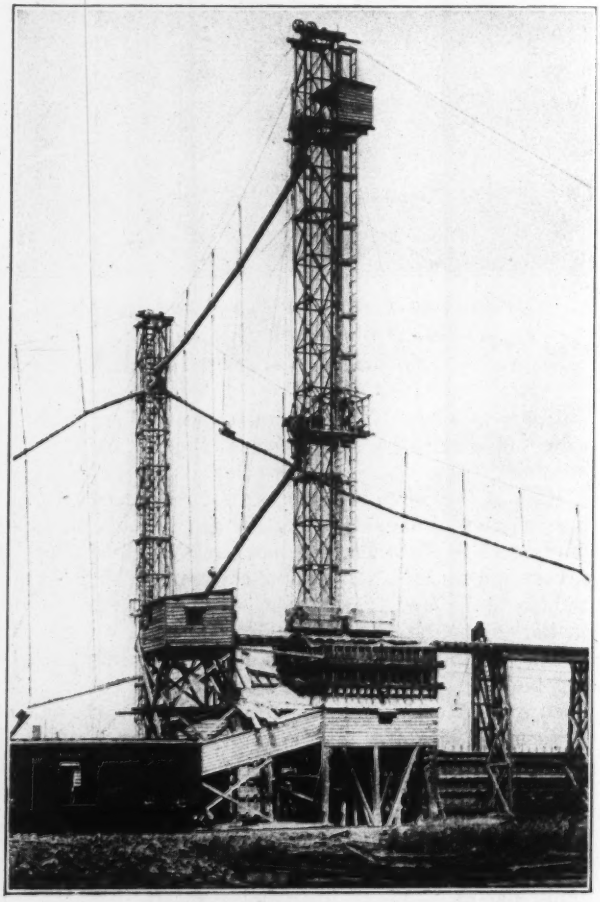


FIG. 1. MIXING PLANT AND HOIST TOWERS

with a complete system for the recovery of coal by-products.

The ground is very poor for foundation purposes, being made up of a considerable depth of silt underlain by strata of sand and gravel. Bedrock or hardpan is found very deep. A peculiarity of the soil, however, is that after piles have been put down and left a while it is practically impossible either to withdraw them or drive them farther. The packing of the material by a number of piles seems to bind them very tightly in place. On account of this peculiarity of the soil only the heaviest loads are

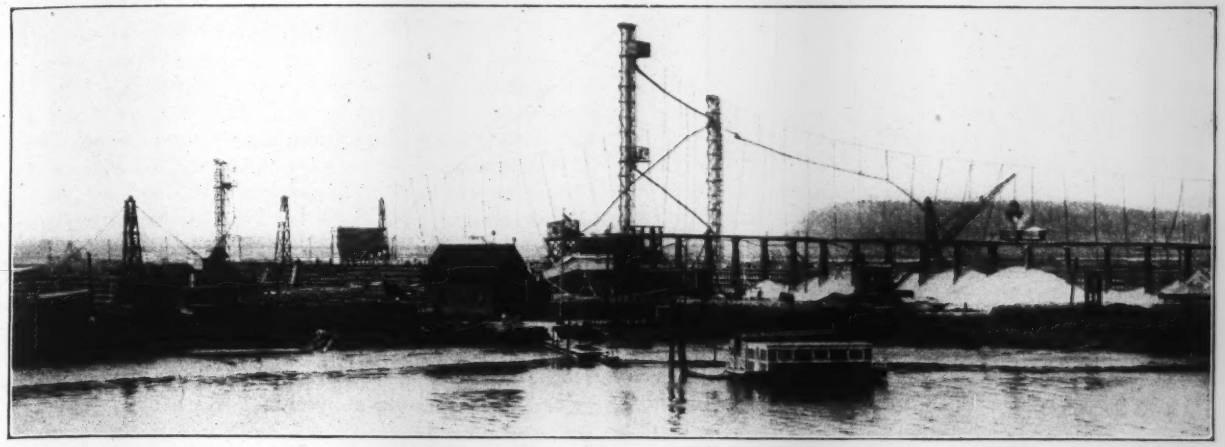


FIG. 2. GENERAL VIEW OF CONCRETE-DISTRIBUTING PLANT OF H. KOPPERS CO. AT JERSEY CITY

carried on piles driven to rock. The total number of piles required for the foundation work in this plant will be about 15,000.

The first operation for foundation work was to put down piling for the oven batteries and the two 200-ft. stacks. The remainder of the piles for the byproduct building, tanks, etc., are being put down as needed. As soon as the piles for the ovens and stacks were in place, the concrete plant was erected. This is an extensive system and is shown by the views.

The concrete materials are delivered to a dock by barges on the Hackensack River. The materials are unloaded into an elevated hopper at a temporary wharf, by means of a stiff-leg derrick equipped with a grab bucket. This hopper is built over a narrow-gage track running on a timber trestle from the dock to the main hoist tower. Two cars coupled together are operated on this trestle by means of an endless cable. The cars are loaded under the hopper, which is provided with two outlets, and are then hauled up the trestle incline and dumped either in bins at the mixing plant or into storage piles along the way. When sand or crushed stone is required from the storage piles, it is loaded into the two cars by the locomotive crane, shown in Fig. 2, and then conveyed directly to the mixing bins.

The mixing plant consists of a ¾-yd. Lakewood mixer with the necessary sand and stone bins and a cement hoist connected to the mixing platform by means of a belt conveyor. Water is piped directly to the mixer platform. The mixer discharges into a bucket elevator operating in a 135-ft. Lakewood steel hoist tower. From this tower, concrete is conveyed by chutes either directly to

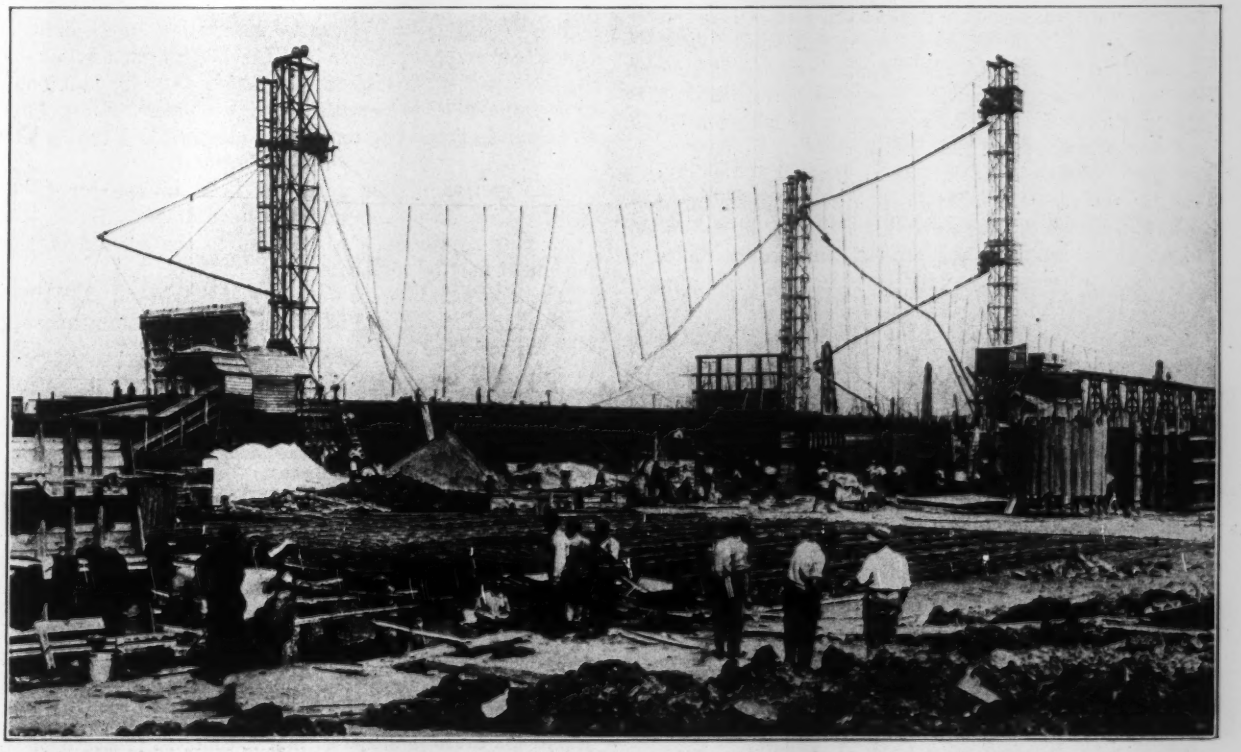


FIG. 3. GENERAL VIEW OF SEABOARD BYPRODUCT COKE CO. OF NEW JERSEY

forms, or it is relayed to the forms through a second tower 105 ft. high and about 100 ft. distant from the first tower.

Concreting is carried on night and day. Davis floodlight projectors furnish excellent lighting for the night work. Quarters have been erected for about a hundred laborers who live right on the job.

Concreting was started on July 1 and is going forward at the rate of 400 cu.yd. per day from one central plant. The total concrete work will amount to 35,000 cu.yd., with about 700 tons of reinforcement. A standard flat-car has just been equipped with another ¾-yd. concrete mixer with tower to do the concreting that is beyond the economical reach of the central plant. This work is carried on under the direction of T. S. Fillebrown, Erecting Engineer for H. Koppers Co.

Resurfacing Concrete Pavement with Reinforced Concrete

The practice of resurfacing worn-out concrete pavements on country roads is too new to have accumulated much in the way of actual experience. Bituminous carpets have been tried, and brick pavements have been suggested for resurfacing, but so far as now appears, the Board of Road Commissioners of Wayne County, Michigan, is the first highway authority to try resurfacing concrete pavement with new concrete.

The road selected for the experiment was built in 1910 as a two-course pavement. It was 6½ in. thick and 16 ft. wide, laid on a crowned subgrade. The 4-in. bottom course was 1:2½:5 mix, using crushed limestone for the coarse aggregate. The wearing course, 2½ in. thick, was 1:2:3 mix, crushed fieldstone being used. The pavement was laid in 25-ft. sections with ¼-in. tar-paper strips for joints.

The surface was struck off with a templet and was somewhat irregular in finish, as the same care and thoroughness that are found in the present practice were not exercised at that time with regard to finishing. The edges of the road were rounded off with about a ¾-in. radius (a practice since abandoned).

A traffic census in 1912 showed about 7,500 vehicles a week, of which 40% were horse drawn. The territory has been built up rapidly since this traffic count was taken, and an actual count at the present time would undoubtedly show a very material increase in the number of vehicles passing the section where the road is reconstructed.

Road Widened and Resurfaced

To accommodate better this increased traffic, it was decided to widen the road to 20 ft. In order to do this the rounded edge was broken off, and concrete was added on each side of the old road to bring it to the required width. A 1:2:4 mix, 6 in. thick, of washed and screened pebbles and washed and screened sand—of the same quality as the present specifications require—was used.

All the Tarvia surfacing and filling used to cover the cracks were removed. The cracks and holes were then filled with concrete to make an even surface 20 ft. wide. The expansion joints were mostly worn down. Where a joint was spalled to a considerable extent, the old concrete was broken away sufficiently to give a bond for the new concrete on both sides of the joint. Expansion felt was then placed in the joint and the whole surface brought to an even grade.

On top of this base was placed a 3-in. layer of 1:1½:2½ concrete—using Marquette (Mich.) traprock, graded in size from ¼ to 1 in. for the coarse aggregate, and washed and screened bank sand for the fine aggregate. This surfacing is in no place less than 3 in. thick and is reinforced with No. 26 triangular-mesh wire.

No attempt was made to bond the top course to the old base with a rigid bond. The surface of the old concrete was first sprinkled with water, then a hot mixture of Tarvia A and Tarvia X was sprinkled over it, using an ordinary hand sprinkling can. This was done immediately before placing the new wearing surface. The Tarvia, falling on the moist concrete, spread out in a very thin layer and was immediately chilled, thus forming an even coat over the old surface.

The expansion joints in the new top course were made to coincide exactly with the expansion joints in the bottom course. A piece of wood 3x4 in. by 20 ft. long was laid over the old joint and the concrete deposited as though no joint was to be made. A Baker automatic finishing machine was used to finish the surface. Afterward, this piece of wood was removed and armor plates, suspended from installing bars, with expansion felt between, were set in place, the felt of the new joint meeting the tar paper of the old joint.

No Adhesion of Old to New Concrete

This method of entirely separating the old base from the new surface was decided to be better than pouring the top course directly on the old surface, as a slight movement due to difference of expansion or heaving would result in cracks in the top course if they were rigidly bonded together. The Tarvia, although very thinly spread, permits a slight movement of each course without interfering with the other.

Before trying this type of construction small slabs of concrete were made, a coat of Tarvia was put on top and another course of concrete deposited. It was found not only impossible to separate the two layers, but a blow sufficient to crack the top course also cracked the bottom one.

This section of the road has been in use for about three months, and a few cracks have developed. A year from now a positive statement as to the success of this pavement may be forthcoming.

The above data were furnished by Edward N. Hines, a member of the Board of Wayne County Commissioners, who writes that he wishes it understood that the work described is considered entirely experimental.

Accidents on State Highways do not make the state liable for dam[illegible] even though the accident was due to negligence of emplo[illegible] of the State Highway Department, according to a decision just rendered in Pennsylvania. Under the Pennsylvania constitution, in order to bring a suit for damages against the state, an enabling act must be passed by the state legislature. William D. Dietrich, of Indiana, Penn., was authorized by an act passed June 8, 1915, to bring suit against the state to recover damages for injuries suffered while driving on a state highway. The attorney-general of the state filed a demurrer, claiming that the action could not be maintained. In the Court of Common Pleas, Judge L. L. Davis decided that the state was not liable for the wrongful acts of its officers or agents, such as those in charge of highway work, unless it had voluntarily assumed such liability. An act permitting the injured party to bring suit merely placed his cause in shape so that it could be passed upon by the court

Motor Trucks Ruin Improved Granite-Block Pavement

A remarkable example of the destruction by the action of motor trucks of a pavement especially designed for heavy traffic is to be seen on West 42d St., New York City.

The motor trucks that carry broken rock from the subway excavations to the waterfront run down 42d St. They are four-wheel rubber-tired tractors hauling steel-tired two-wheel trailers, the whole vehicle with its load of rock-piled skips weighing some 19 tons. On the block from 9th to 10th Ave. the traffic is not dense, there is a slight down grade, and the loaded trucks frequently obtain speeds estimated at 15 to 20 mi. per hour. The terrific impact of these vehicles was sufficient in only some four months to crush a number of the granite paving blocks to powder and leave holes in the pavement, necessitating

FIG. 1. WEST 42ND ST., NEW YORK CITY, SHOWING DAMAGE TO PAVEMENT

relaying 79% of it on the north side of the street, the side used by the loaded trucks.

This stretch of pavement was laid in 1912 under the Borough of Manhattan specifications for improved granite-block pavement.[1] H. W. Durham was then chief engineer of the Bureau of Highways. The pavement is similar to many others laid about the same time and since, which are showing excellent wearing qualities. It ought to have been good, in the estimation of experts, for at least 25 years' service. The failure of the pavement by grinding up and splitting of the granite blocks was unlooked for and most extraordinary. It furnishes ample proof that a city engineering department can hardly hope to design a pavement that will stand up under such traffic.

The half of the pavement north of the street-car tracks on this block has an area of 1,850 sq.yd. On Apr. 15 of the present year the pavement was carefully gone over, and minor repairs were made, which put it in first-class condition. Between Apr. 15 and Aug. 24 this north-side

[1]Square-cornered 6-in. granite blocks, 1-in. sand cushion and 6-in. concrete foundation. Blocks laid with not more than ½-in. joints, bituminous filled.

FIG. 2. NEARER VIEW OF HOLES IN GRANITE-BLOCK PAVEMENT

pavement suffered damage that required, between Aug. 24 and Sept. 16, the relaying of 1,470 sq.yd., or 79% of the whole area. New blocks were required for 12% of the area relaid. The cost was not less than $2,000.

The evidence shows practically conclusively that the damage was done by the extraordinarily large motor trucks used to haul to the North River waterfront the material excavated for the new Broadway subway. The loading and handling of these trucks were briefly described in *Engineering News*, Feb. 17, 1916, p. 324. An accompanying view shows one of these trucks. About two-thirds of the load of the six large steel rock skips carried comes on the steel-tired wheels.

The speed of these heavily loaded vehicles on an open stretch of level pavement, such as that on West 42d St. between 9th and 10th Ave. is almost unbelievable. An estimate of 15 to 20 mi. an hour has been made by several trustworthy observers. The effect of 12,000-lb. wheel loads on 8-in. steel tires at this rate of speed is ruinous to any pavement. The impact of the wheels jumping from one slight hump to another crushed and split the granite blocks to fragments, as is shown in Fig. 4, notwithstanding whatever cushioning effect the sand bedding may have had.

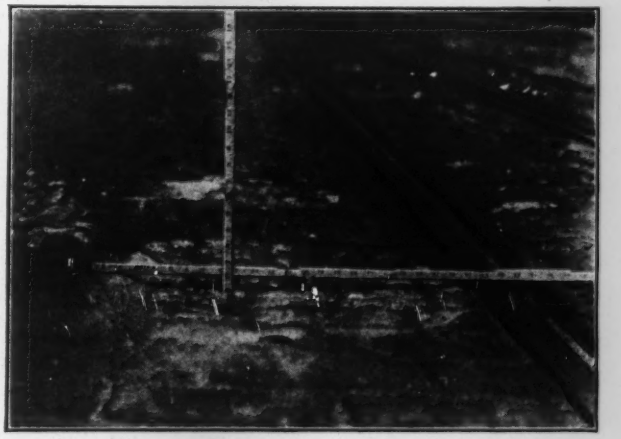


FIG. 3. WHEEL RUTS ALONG STREET-CAR RAIL

The theory has been advanced that the pavement would have suffered less had it been of smooth cement-grouted-joint type. This is probably true to a certain extent, yet ever so small a depression or hump would have started the hammering on adjacent blocks, and the result sooner or later would have been the same, for one depression inevitably leads to another. It does not appear that the quality of the granite was a contributing cause, for paving blocks in 10th Ave., which is of the toughest and hardest granite used in New York City paving work, have begun to go in exactly the same way.

It is evident that the speed of these vehicles is a larger factor in the destruction of the pavement than the wheel loads, extraordinarily heavy though they are. Other cross-town streets used by the same vehicles are narrower and do not permit of the speed possible on 42d St., and the pavements on these streets show less damage. Moreover, during the period referred to the larger part of the traffic apparently went via 42d St.

Investigation showed that the concrete foundation under the blocks had not been injured, but had remained

FIG. 4. SHOWING HOW BLOCKS ARE BROKEN AND CRUSHED

intact. The failure of the pavement is wholly one of crushing of the granite-block wearing surface under traffic —an unheard-of thing up to this time.

In making repairs, as many of the old blocks as were sound were reused, but about 12% of new blocks was required to take the place of those crushed. The blocks were relaid on a 1:4 cement mortar bedding, according

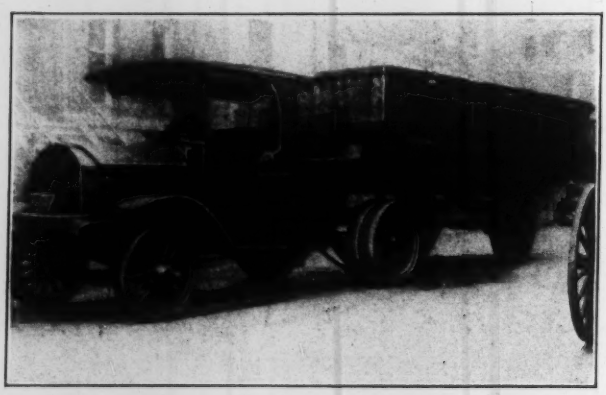


FIG. 5. TYPE OF MOTOR TRUCK WHICH DOES THE DAMAGE

FIG. 6. ASPHALT-CARPETED SURFACE, SHOWING ABRASION ON BLOCKS BELOW

to the present practice of the Bureau of Highways, under E. W. Stern, chief engineer.

The joints were refilled with asphaltic grout, and a carpet coating of the same material was spread over the surface of the pavement for the purpose of cushioning the effect of any future hammering. The result has not been wholly satisfactory, as Fig. 6 shows. The heavily loaded steel-tired wheels are picking up the asphalt carpeting, and the white powder of crushed granite has already (Sept. 21) begun to appear on the relaid blocks.

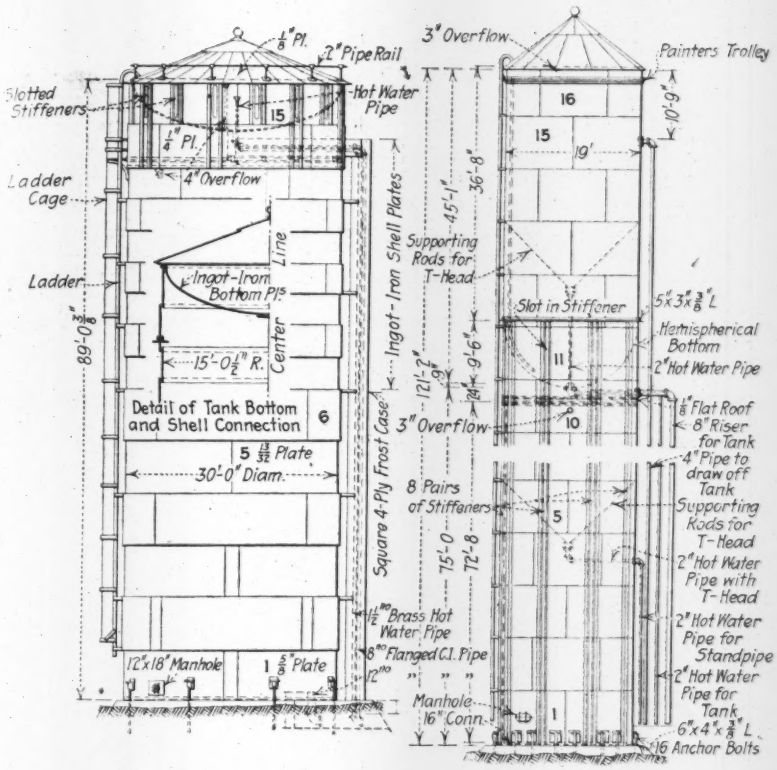
The corporation counsel of the City of New York has advised against an attempt to collect damages, on the ground that the pavement is not new, and that it may not be legally proved that the damage was done by the particular trucks in question. New York, like most other American cities, has no special ordinance limiting wheel loads or motor-truck speeds, to prevent damage to pavements. There are instances, however, where the city has collected damages for manhole covers broken by excessively heavy loads.

Combination Standpipes and Elevated Water Tanks

A standpipe having an interior diaphragm or bottom so that its lower portion may be used for ordinary storage while its upper portion is converted into an elevated pressure tank for fire-protection sprinkler service is an interesting type of structure, of which two examples are described below. Both of these were designed and built in 1915 by the Chicago Bridge and Iron Works, of Chicago.

The combined standpipe and tank, shown at the left in Fig. 1 and in Fig. 3, is at South Poland, Maine. It was built for Hiram Ricker & Sons, bottlers of the Poland spring water. It is 30 ft. in diameter, with a total height of 90 ft. The tank portion is shallow, being formed by a segmental bottom of the builder's standard type attached to the inside of the upper edge of the top course of shell plates. The capacity of this sprinkler tank is 26,000 gal., while that of the standpipe proper is 400,000 gal.

The load of the tank is carried directly by the shell of the standpipe, stiffeners being riveted only on the top courses, as shown in Fig. 2. A peculiar feature is that the stiffeners are slotted in order to provide openings through which the upper portions of the seams of the



FIGS. 1 AND 2. DETAILS OF TWO COMBINATION STANDPIPES AND TANKS

Fig. 1 (Left)—Construction of combined standpipe and tank at South Poland, Maine, showing detail of tank bottom. Fig. 2 (Right)—Combined standpipe and tank at Maywood, Ill., showing tank bottom and pipe connections

tank bottom could be reached for riveting. The lower portions of these seams are accessible from the inside of the standpipe. Another feature is the use of a safety ladder, having a cage on the outer side to prevent men from falling.

The water-supply is led to the tank through an outside 8-in. pipe that runs horizontally across the top of the standpipe to its connection at the center of the tank bottom. A platform in the standpipe affords access to this pipe connection. The overflow outlet of the standpipe is so placed that the water cannot rise to the level of the platform. There is also a hot-water pipe leading into the tank. Both pipes are inclosed in a frostproof casing. The 8-in. pipe serves for both inlet and outlet.

A very novel and interesting feature in this structure is the use of Armco rustless ingot-iron plates for the tank bottom and for the upper courses (about 30 ft.) of the standpipe shell. As these plates are not rolled in wide sizes, these courses are only about 4½ ft. high, while the lower portion of the standpipe has 7½-ft. courses of steel plate. The owners decided on this use of special metal for the reasons that the air beneath the tank bottom will be laden with moisture and that the upper part of the standpipe will be alternately wet and dry, according to the varying level of the water. The structure was given two coats of graphite paint, one at the shops and the other after erection. The frostproof casing received two field coats of graphite paint.

The combination standpipe and tank shown at the right of Fig. 3 and in Fig. 2 has a much larger proportion of its contents utilized as a sprinkler tank. It is at the plant of the American Can Co., at Maywood, Ill. The diameter is 19 ft., and the total height is 121 ft. The standpipe portion is 75 ft. high (72 ft. 8 in. to water level), with a capacity of 154,000 gal. The tank portion is 45 ft. high, with a capacity of 90,000 gal. It has a standard hemispherical bottom, as shown in Fig. 2. For each portion there is a 2-in. pipe for hot water, this being of brass inside the tank and standpipe. Owing to the much greater tank load in this case, the standpipe is reinforced for its full height by stiffeners extending from an outside 5x3-in. angle-iron ring at the level of the base of the tank to the base of the standpipe. These stiffeners, eight in number, are composed of pairs of angles 3x2½x$\frac{5}{16}$ in. They are slotted at the top for riveting the tank-bottom seams, as in the other structure. Between the bottom of the tank and the standpipe overflow outlet is a flat roof of ⅛-in. plates supported by 6-in. channels spaced 24 to 36 in. c. to c. and having their ends resting on an interior angle-iron ring.

FIG. 3. COMBINATION STANDPIPES AND ELEVATED SPRINKLER TANKS

The one at the left is at South Poland, Maine. The other is at Maywood, Ill.

Stirrup Spacing Diagrams

By Frank S. Bailey*

The diagrams here shown give the spacing of vertical stirrups in reinforced-concrete beams for both the U- and the W-shaped stirrup, for rods of $\frac{5}{16}$, $\frac{3}{8}$ and $\frac{1}{2}$-in. diameter and for steel tensile values of 16,000 and 18,000 lb. per sq.in. They are based on the Joint Committee specifications according to the formula

$$S = \frac{\frac{3}{2} a_s f_s jd}{V}$$

in which

S = Spacing of vertical stirrups in inches;

a_s = Total sectional area of steel in stirrup in square inches;

f_s = Allowable fiber stress in stirrup per square inch;

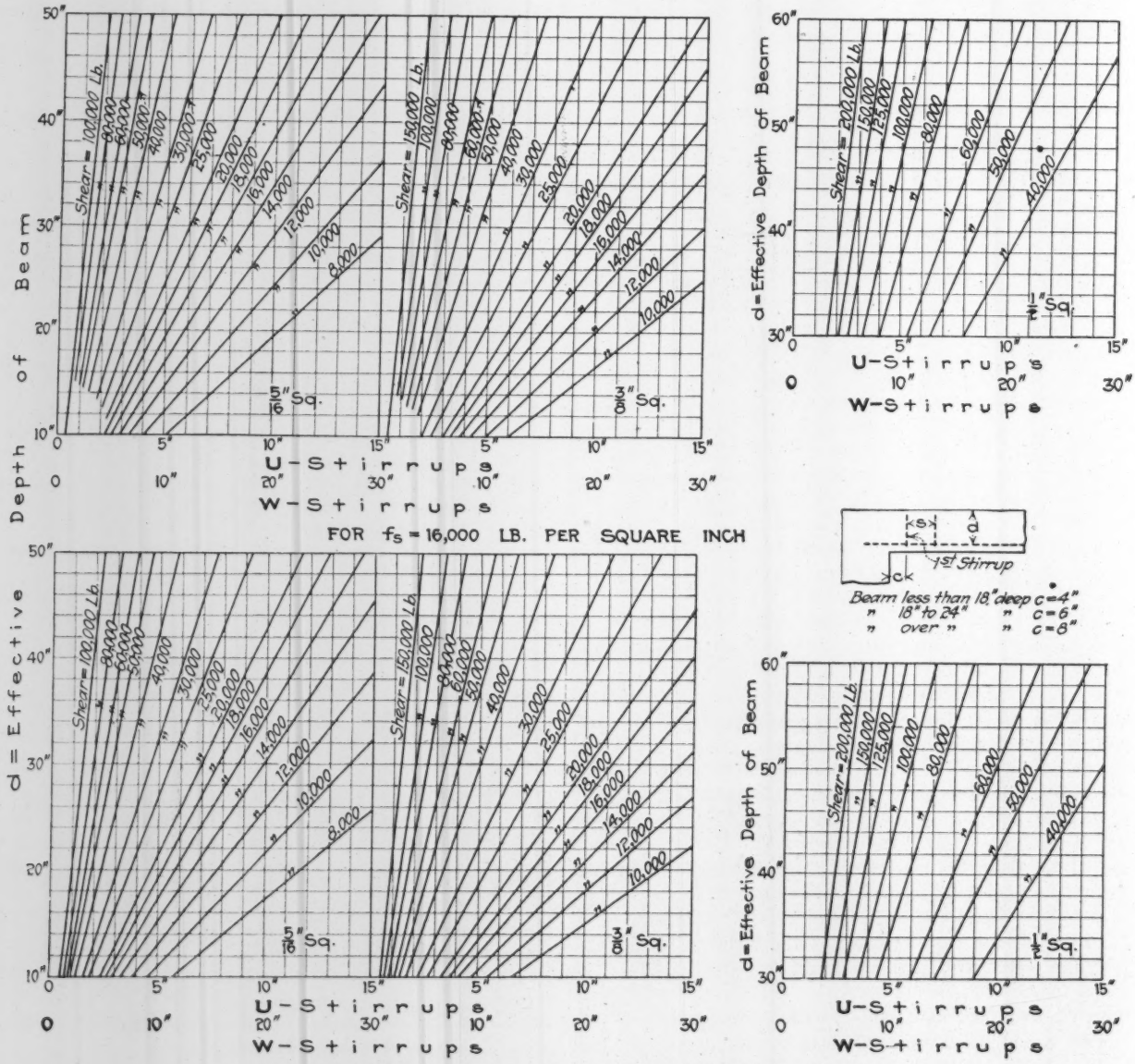
j = Ratio of lever arm of resisting couple to depth d;

d = Depth of beam to center of steel in inches;

V = Total shear in pounds.

The formula is based upon the assumption that two-thirds of the total shear produces stress in the stirrups and that one-third is taken care of by the concrete. If the safe unit shearing stress in the concrete is taken at 40 lb. per sq.in., then the cross-section of the beam must be so proportioned that $v = \frac{V}{bjd}$ shall not exceed three times 40 lb., or 120 lb. (v = shearing unit stress and b = breadth of beam in inches). The minimum spacing of stirrups will be required at the end of the beam where the largest shear occurs. The distance from the edge of the supporting column or wall to the first stirrup in the beam may be taken as one-half the minimum spacing; that is the practice with one firm which does a great deal of construction. Another firm uses the fol-

*Stone & Webster Engineering Corporation, 112 Charles River Road, Cambridge, Mass.


Depth of Beam
d = Effective Depth of Beam
Shear = 100,000 Lb.
Shear = 150,000 Lb.
Shear = 200,000 Lb.
5/16" Sq.
3/8" Sq.
1/2" Sq.
U-Stirrups
W-Stirrups
FOR fs = 16,000 LB. PER SQUARE INCH
FOR fs = 18,000 LB. PER SQUARE INCH
1st Stirrup
Beam less than 18" deep c = 4"
" 18" to 24" " c = 6"
" over " " c = 8"

DIAGRAMS GIVING STIRRUP SPACING IN REINFORCED-CONCRETE BEAMS

lowing rule: For beams 18 in. or less deep, distance to first stirrup equals 4 in.; 24 in. deep, 6 in.; over 24 in. deep, 8 in. One well known textbook advises placing the first stirrup 2 in. from the support in all cases.

In beams uniformly loaded, as the shear varies from a maximum at the support to zero at the center, the spacing at any part of the beam is easily found after the minimum spacing at the support is known. Thus if m = the spacing at the support and l = the length of clear span then at a distance $\frac{l}{8}$ from the support the spacing will be $^4/_3\ m$, at a distance $\frac{l}{4}$ the spacing will be $2\ m$, while at a distance $\frac{l}{2}$ no stirrups are needed. It is recommended by the Joint Committee that the longitudinal spacing of stirrups should not exceed three-fourths the depth of the beam. Where concentrated loads occur it is necessary to know the shear at these points.

To illustrate the reading of the diagram, suppose a total shear of 40,000 lb. is to be provided for by a beam 12 in. wide, where the concrete can be safely stressed to 50 lb. per sq.in. and the steel to 18,000 lb. per sq.in. The unit shear for concrete and steel together therefore must be limited to 150 lb. per sq.in. (concrete taking one-third total shear) or $150 = \frac{40{,}000}{12 \times \frac{7}{8} \times d}$ and $d = \frac{40{,}000}{150 \times 12 \times \frac{7}{8}} = 25.4\ in.$

Calling $d = 26$ in. and assuming $\frac{5}{16}$-in. square stirrups of the W type will be used, we start at the side of the diagram at an effective depth of 26 in., go horizontally to the diagonal line "shear = 40,000 lb.", then vertically down to the bottom where it is seen that $\frac{5}{16}$-in. W stirrups should be spaced about 6 in. apart.

If a larger shear than 40,000 lb. were to be designed for, the section of the beam would have to be changed—by being made wider or deeper—and if a shear of 20,000 lb. only had to be taken care of, a considerably smaller section could be used—if the shear alone were the only factor to be considered. On a lightly loaded beam of long span the section necessary for resisting the bending moment is often the controlling factor.

New Method of Deriving Weir Formulas

By Theodore R. Running*

A new method of determining the rate of flow of water over weirs has been tried in the hydraulic laboratory of the University of Michigan with gratifying results. The main advantage in the new method is that it requires only a single experiment for determining the rate of flow of water over a weir for different heads and is applicable to weirs of high as well as of low heads.

The experiment described below was carried out with the assistance of C. N. Ward, H. R. Leach, T. A. Nagler and A. F. Sherzer, all graduate students in the College of Engineering, University of Michigan. To the critical judgment and valuable suggestions of H. W. King, Professor of Hydraulic Engineering in the University of Michigan, the writer is particularly indebted.

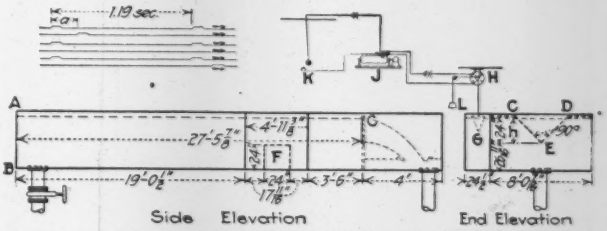
*Associate Professor of Mathematics, University of Michigan.

Fig. 1 shows the relation of the different parts of the tank and other apparatus used in the experiment. The tank ABC had a right-angle V-notch weir fitted into the end at C. The weir was made from a $\frac{1}{4}$-in. steel plate, beveled to a sharp edge, though not a knife-edge. Inside of the weir was a closely fitting gate that prevented the water from flowing out until ready to begin the experiment. Water was pumped into the tank through the pipe at B. Precautions were taken to prevent leakage through this pipe after the pumping was discontinued. A stilling box with float G was connected with the tank by the opening F.

The recording apparatus consisted of a chronograph J, connected electrically with a seconds pendulum at K and with a fixed dial H. A fine wire was wound several times around a shaft to which was attached a hand that completed the circuit at four points on the dial H. One end of the wire was attached to the float, and a counterweight L at the other end prevented the slipping of the wire on the shaft. The distance between two contacts on the dial represented a lowering of the water surface of 0.108 ft.

The pendulum was accurately rated (single vibration 1.19 sec.) and made electric contact through a drop of mercury at K. Contact of the pendulum with the mercury was indicated on the record by a short side movement of the pen (caused by a small electromagnet). Contact on the dial was recorded by another pen.

Part of the record as taken from the chronograph is shown in Fig. 2. This diagram is self-explanatory; it may



FIGS. 1 AND 2. TANK ARRANGED FOR EXPERIMENTS AND PART OF CHRONOGRAPH RECORD

be stated, however, that fractional parts of a second were determined by measuring the distance a, which represents the time between the beginning of contact on the dial and the beginning of the last contact of the pendulum, and dividing it by the distance representing one second. Time was read from the record correct to hundredths of a second, and head correct to thousandths of a foot.

After filling the tank with water and before beginning the experiment it was necessary to determine the height of the water surface above the lowest point of the weir. This was done with a great deal of care. The error in this determination was less than 0.001 ft.

The pendulum and chronograph were now set going, and the weir gate was quickly removed. The lowering water surface carried with it the float, which in turn brought about contacts on the dial. After the water had lowered to within about 1 in. of the lowest point on the weir, the chronograph was stopped and the record removed. From the record the following sets of values were obtained, h being head in feet and t time in seconds:

Values of h	Values of t	Values of h	Values of t
1.661	9.12	0.905	49.22
1.553	10.75	0.797	63.08
1.445	11.94	0.689	85.82
1.337	16.02	0.581	116.60
1.229	21.56	0.473	165.67
1.121	27.75	0.365	253.14
1.013	37.28	0.257	437.28

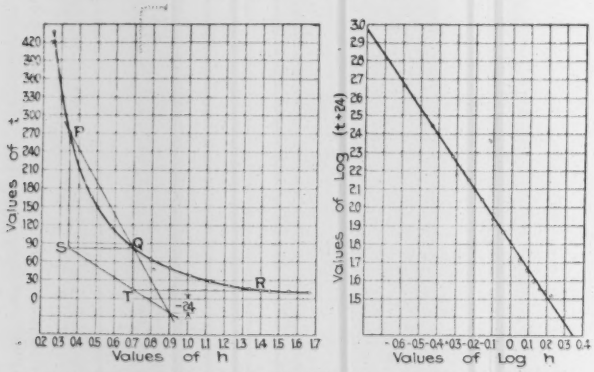
The point from which t was measured on the record was arbitrary and, as will be seen later, affected in no way whatever the final result. It was essential, however, that h represent as accurately as possible the height of the water surface above the lowest point of the weir. The corresponding values of h and t were plotted in Fig. 3. For the purpose of determining the law connecting t and h the following sets of values were read from the figure:

h	t	Δt
0.3	342	—163
0.45	179	—90
0.675	89	—51
1.012	38	—28
1.518	10	....

In the foregoing table the values of h were taken in a geometrical series; and since the first differences (Δt) of the corresponding values of t form very nearly a geometrical series, we conclude that the relation between the variables is expressed to a close approximation (within the limits of the experiment) by the equation

$$t = a + bh^c$$

where a, b and c are constants to be determined by the data. These constants are first determined approximately. Fig. 3 gives a graphical determination of a. The process is as follows: Select any three points P, Q and R whose abscissas form a geometrical series, and locate two other points S and T, as indicated in the figure. The two lines



FIGS. 3 AND 4. PLOTTED RESULTS OF WEIR FORMULA EXPERIMENTS

PQ and ST intersect in a point whose ordinate is a. For, let the coördinates of the points be the following:

$$P = (h_1, a + bh_1^c);$$
$$Q = (rh_1, a + bh_1^c r^c);$$
$$R = (r^2h_1, a + bh_1^c r^{2c});$$
$$S = (h_1, a + bh_1^c r^c);$$
$$T = (rh_1, a + bh_1^c r^{2c});$$

The equation of the line through the points P and Q is

$$t = \frac{bh_1^c(r^c - 1)}{h_1(r - 1)}h + a + bh_1^c - \frac{bh_1^c(r^c - 1)}{r - 1} \quad (1)$$

The equation of the line through the points S and T is

$$t = \frac{bh_1^c r^c(r^c - 1)}{h_1(r - 1)}h + a + bh_1^c r^c - \frac{bh_1^c r^c(r^c - 1)}{r - 1} \quad (2)$$

Multiplying (1) by r^c and subtracting (2) from the result, we have

$$(r^c - 1)t = (r^c - 1)a \text{ and } t = a$$

From Fig. 3 we see that a is approximately —24. In Fig. 4 the logarithms of the values of $t + 24$ are plotted to the logarithms of the values of h as abscissas. The equation of the straight line that most nearly passes through all of the points is

$$log\ (t + 24) = log\ 64 - 1.46\ log\ h.$$

The irregularity of the points near the high heads is undoubtedly due to the disturbance caused by the sudden removal of the gate. The approximate formula then is

$$t = -24 + 64h^{-1.46}$$

Correcting the values of a, b and c by the method of least squares, we obtain

$$t = -24.438 + 63.647\ h^{-1.459} \quad (3)$$

The differential equation that expresses the fluctuation of water level is

$$Qdt = -Sdh \quad (4)$$

where Q is rate of outflow per second of time, and S is area in square feet of the horizontal section of the tank.

By differentiating (3) we obtain

$$dt = -(63.647)\ (1.459)h^{-2.459}\,dh \quad (5)$$

Multiplying this equation by S and dividing by $(63.647)\ (1.459)h^{-2.459}$ we have

$$\frac{S}{(63.647)\ (1.459)}h^{2.459}\,dt = -Sdh \quad (6)$$

Since the right-hand members of equations (4) and (6) are identical, the left-hand members must be. The area of the mean horizontal section of the tank used in the experiment (including the stilling box) was 231.021 sq.ft. The left-hand member of (6) gives for the formula for the particular weir used in the experiment

$$Q = 2.488\ h^{2.459} \quad (7)$$

or less approximately

$$Q = 2.49\ h^{2.46} \quad (8)$$

Since the cross-section of the tank is about 33 sq.ft., the velocity of approach for the maximum value of Q is less than $\frac{1}{3}$ ft. per sec. The correction for this velocity of approach is very small and need not be considered here.

For comparison the table below may be of interest. The column headed Q_1 gives the values of Q computed by formula (8), and the column headed Q_2 gives the corresponding values of Q which Professor King obtained experimentally with the same weir by another method and which he has kindly permitted the writer to use.

h	Q_1	Q_2	h	Q_1	Q_2
0.159	0.027	0.029	1.014	2.580	2.614
0.370	0.216	0.214	1.202	3.919	4.030
0.529	0.521	0.523	1.324	4.971	5.089
0.618	0.764	0.785	1.433	6.037	6.119
0.682	0.973	0.986	1.790	10.440	10.539
0.826	1.558	1.576			

It is noticed that, with one exception, the values of Q_2 are larger than the corresponding values of Q_1. This can be accounted for, to some extent perhaps, by the fact that in the experiments from which the values Q_2 were derived the pump was working continuously and the water thus entering through the pipe at B would give to the water in the tank a slightly greater velocity of approach than that of the water in the experiment from which the values of Q_2 were obtained.

Another element that may help to account for the difference in the corresponding values of Q is the possible lagging of the water in passing from the smaller into the larger tank through the opening at F. Through such a large opening, however, the lagging would be slight at most.

It may be well to point out that the method described is very well adapted for experiments on the flow of water through pipes.

A Standard Capacity for Lime Barrels was fixed by an act of Congress approved on Aug. 23. The law specifies two sizes of barrel—a small barrel to contain 180 lb. net, and a larger barrel containing 280 lb. net. Lime may, however, be sold in smaller containers than the small barrel, provided the net weight is stenciled upon the package.

Municipal Docks at Astoria

By J. P. Newell*

SYNOPSIS—Two piers just completed in municipal-dock enterprise on north Pacific Coast. Structural design of piers fine example of modern timber and earth-fill wharf. Unusual detail in lagging to hold fill. Pier sheds of timber, concrete and clay tile, specially designed to be fireproof.

The Port of Astoria, Astoria, Ore., at the mouth of the Columbia River, has been engaged for the past two years in constructing municipal terminals for the accommodation of ocean-going traffic. Two piers 1,300 ft. long have been built, inclosing a slip 400 ft. wide at the entrance and 250 ft. at the rear end. Some features of the construction are believed to be novel and of interest to engineers.

The general type is that of a pile structure inclosing an earth-fill (Fig. 3). The bulkhead is 7,000 ft. in length and the entire area inclosed is 43 acres, filled to grade with material dredged from slips and channel. The original depth of water at mean low tide varied from 0 to 23 ft., averaging 15 ft. The slips have been dredged to a depth of 30 ft., but an extra depth of 5 ft. is contemplated at a later date. The first dredging was done along the toe of the slope to permit the lagging to be placed.

The method of holding the sand-fill in place is shown in Fig. 3. Against rows of piles 10 to 16 ft. apart, panels made up of 6x12-in. lagging were placed in steps so as to form a 1 on 2 slope, the lower edge of each panel being 2 ft. lower than the top of the one next below it. Hemlock planks were used for lagging, with 3x16-in. fir stay lath spiked on about 4 ft. apart. Panels 100 ft. long were built in place against the piles at the water surface. Guide piles were tried at first to hold the panels during the sinking but on account of the tendency to move endwise it was found better to use yokes, each composed of two ¾-in. bolts and an 8x8-in. by 6 ft. timber, ample room being left to allow for irregularities in the spacing of the piles. At least four yokes were used for each panel, and they were placed alternately at the top and bottom edges.

The chief difficulty in sinking was caused by rapid flow of the tides, which vary from 4 to 12 ft., with a maximum velocity of 4 mi. per hr. The sinking was accomplished by means of a piledriver at each end of the panel. A "push-down stick," 8 in. square and about 50 ft. long, with scabs bolted on the lower end to make a fork, was framed in the leads, the hammer being removed. The pile line was attached to the top of the stick and run through a block at the bottom of the leads and thence to the drum. A shorter stick for each driver was set up at an intermediate point and held in place by a turn of a line around a pile. For these the blocks were fastened at the water surface and the lines carried to the niggerheads on the drivers. By means of these lines the panels were pushed down to the proper depth and held there by stay lath bolted to the piles.

Except for an occasional stay lath broken by drift logs, but little difficulty was found in holding the panels below

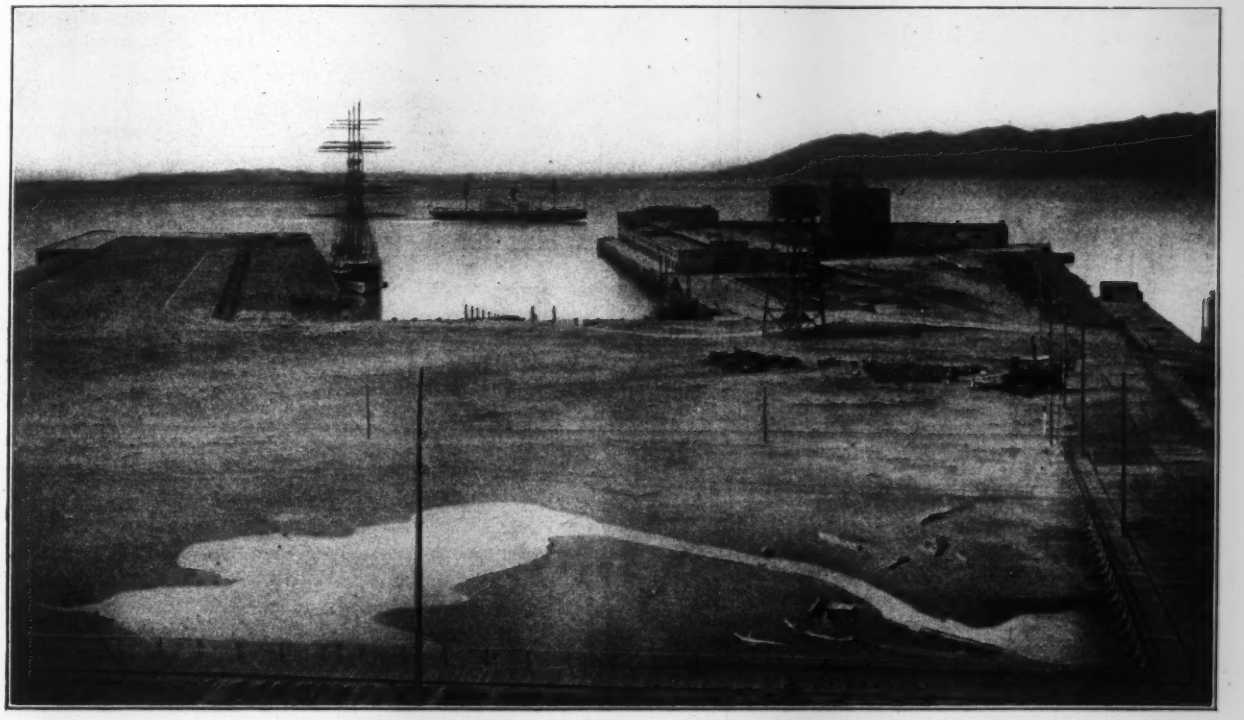


FIG. 1. LOOKING OUT UPON THE NEARLY COMPLETED MUNICIPAL DOCKS AT ASTORIA, ORE.

*Newell, Gossett and Walsh, Civil Engineers, Spalding Building, Portland, Ore.

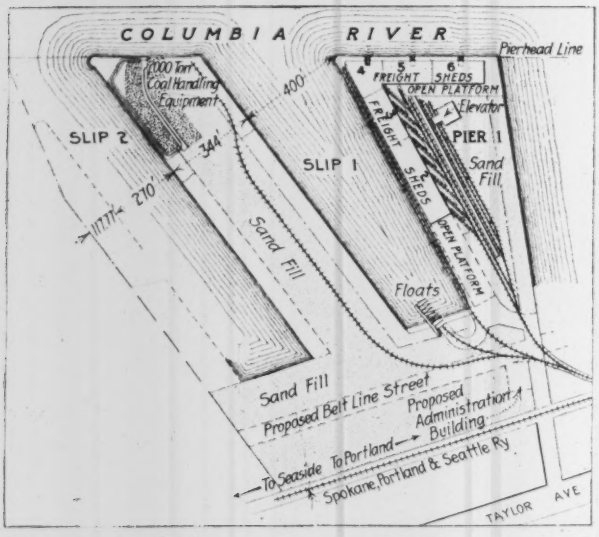


FIG. 2. GENERAL PLAN OF ASTORIA MUNICIPAL DOCKS

low water, but with those between high and low tide considerable trouble was experienced. The southwest gales sometimes reached a velocity of 60 mi. per hr., with a sweep across 2 or 3 mi. of open water before reaching the dock site. The lagging had to withstand the force of the waves thus created until it could be supported by the backfilling.

As soon as the lagging had been placed a sufficient distance ahead, material from the slip was pumped in behind it. A suction dredge with 24-in. pipe was used, and 1,250,000 yd. was deposited in the piers. Dredging operations extended from September, 1914, to May, 1915. The material handled was mostly fine heavy sand, but the remainder was sand mixed with finely divided clay, making, when pumped, a nearly fluid mass. Below low water there was very little difficulty in holding the dredged material. Above low water the presence of clay caused frequent blowouts with considerable loss of material. With clean sand the 2-ft. seal between successive panels was sufficient, but the clayey material would find its way out through even the smallest opening. Cracks were battened with inch boards and burlap, but in spite of all precautions breaks occurred which had to be stopped with brush and sacks. An additional foot of seal would have reduced these troubles, but the extra expense would not have been justified. Wave action caused some damage by washing out sand over the top of the lagging, and it was found necessary to follow up closely with the riprap.

The slopes were covered with rock from 1 to 4 ft. deep. In sheltered places the riprap was carried down to only about 5 ft. under low water, the lagging being relied on to protect the fill below that level. Rock from egg size to 2 ft. in diameter was used, the object being to make the densest possible covering in order to protect the fine sand underneath. About 35,000 yd. was required.

Details of Track Layout

Special attention has been paid to track facilities. In the rear of the building the tracks are arranged in short spurs holding two cars each, with platforms between. This enables cars to be "spotted" with the least possible interference with the loading of other cars.

The herringbone tracks serve only for freight passing through the building. A three-rail track is provided along the front side of the dock for freight passing directly between cars and ships. This arrangement permits cars to be placed close to the edge of the dock or at a sufficient distance back to make room for handling slings. It gives most of the advantages of a double track, with a saving of space and consequent distance of trucking.

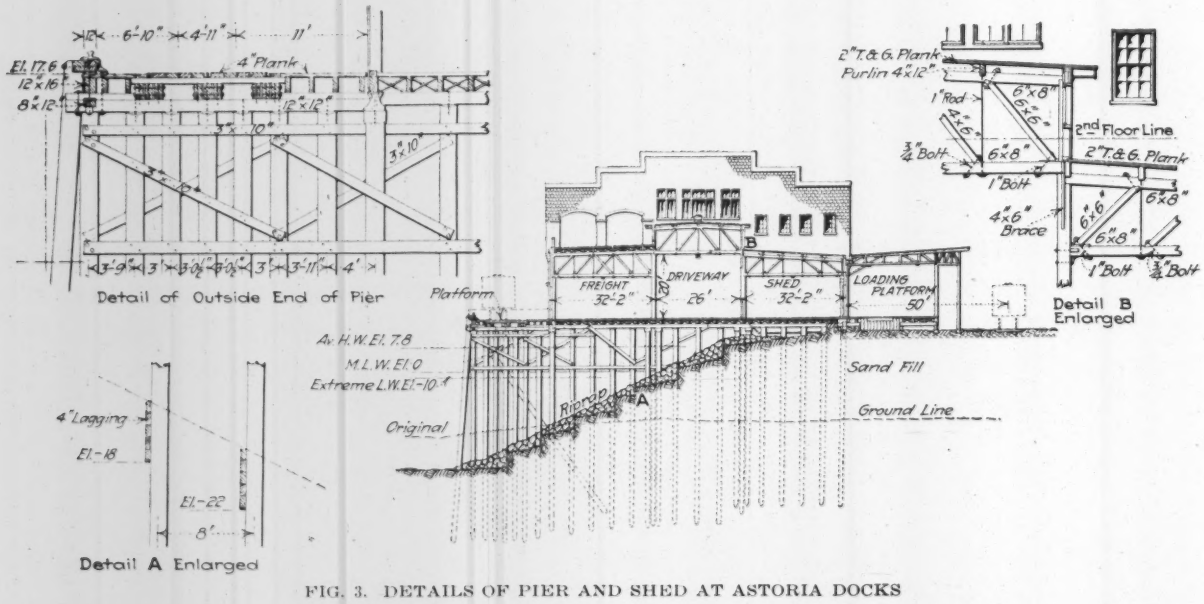


FIG. 3. DETAILS OF PIER AND SHED AT ASTORIA DOCKS

Building Construction

The building on Pier 1 occupies the side and the end of the pier and is 1,085 ft. in length by 90 ft. in width. The frame is of timber; all inclosing walls and the five fire walls are built of Denison interlocking hollow tile. The roof is carried on transverse wooden trusses, the wall ends being supported on reinforced-concrete columns, which are in turn incased with 4-in. tile. The curtain walls between columns are 8 in. in thickness, reinforced

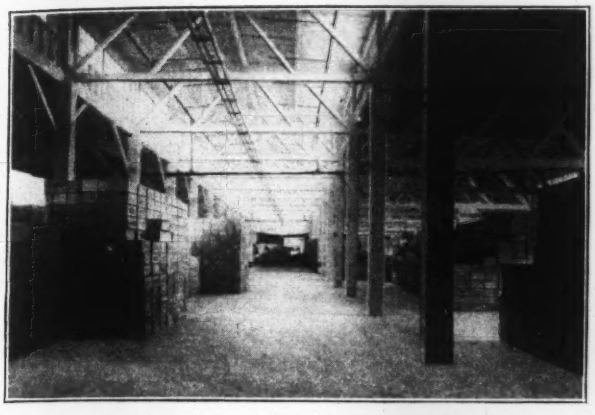


FIG. 4. INTERIOR OF ONE OF THE ASTORIA PIER SHEDS

with 5/8-in. horizontal rods every 3 ft. in height, grouted in the joints. All fire walls are 12 in. thick and extend 3 ft. above roof lines.

A driveway, with a clear width of 26 ft., extends the entire length of the building. The bent centers are 15 ft. 6 in. apart. Doors and windows are placed in each alternate bay. The doors are a standard type of roller steel door, with a clear width of opening of 12 ft. The substructure has been designed to carry 750 lb. per sq.ft. The windows are all of steel sash set directly in the tilework, eliminating the common objections found in the use of wooden frames. The steel sash has been glazed throughout with 1/4-in. ribbed glass. Owing to the continuous monitor windows and the use of white paint on the interior, the dock is exceptionally well lighted.

The electric wiring has been run in conduit, with all outlets located on the truss chords. Control cabinets are located on the fire walls, and additional switches conveniently placed govern small groups of light for loading purposes.

Fire Protection Specially Considered

The building is well equipped with fire-fighting apparatus. In addition to a dry-pipe sprinkler system the interior is protected by 2½-in. standpipes with hose attached. Outside fire hydrants are located at regular intervals, and all hose and hydrant connections are the same as the city standard.

In addition to the special fire protection there are six 3-in. water lines carried to the face of the dock to provide water-supply for ships; these are terminated by a Siamese Y-branch having a fire-hose coupling. A 50,000-gal. tank is used as an auxiliary supply to the main water-supply from the city mains.

The sprinkler system proper, not including supply mains, includes 2,550 heads and cost $12,000. The hydrants, standpipes, water-mains and tank were let under separate contracts and aggregate an additional $8,500. This equipment, together with the type of building, has made possible a very low rate of insurance on the building as well as on commodities placed in storage, the average rate being 40c. on a 3-yr. policy.

Ramp Equipment

In anticipation of the transfer business six small slips have been provided with adjustable ramps for the handling of freight to and from river boats and barges. The ramp platforms have been equipped with an especially designed booster chain to carry the loaded trucks up the incline. Two flat top chains are used, running on rollers in channel-iron guides placed on the same centers as the wheels of the trucks used on the dock. The chains are driven by sprocket wheels mounted on the hinge shaft and have semi-attached steps that engage the truck wheels until the top of the incline is reached, when they automatically drop and pass through the opening in the floor with less than 1/4-in. clearance, eliminating the frequent accidents heretofore met with in the use of the various types of boosters on the market.

The railroad tracks are carried across the slips by movable platforms that are raised and suspended above the openings when the slips are in use. The raising of the platform, the adjustment of the ramp and the driving of the booster chain are accomplished by means of a 7½-hp. alternating-current motor placed under the dock floor, as shown in Fig. 5, controlled by a drum-type controller with reversing handle connected with reversing variable-speed motor. The three levers controlling the various operations are interlocking and engage friction clutches under the dock floor. A speed of 280 ft. per min. for the travel of chain was found to be the most efficient.

The cost of a ramp complete, including steel trussed beams, all mechanical equipment and power transmission, was $3,000.

A satisfactory improvement has been made in the cleats by the extension of the back part to a bearing on a timber a foot below the stringpiece on which the cleat rests. This prevents bending or shearing strains on the bolts.

Data on Unit and Total Costs

The price paid for dredging was 12c. per yd., but this figure was made possible only by the fact that the work was measured in excavation, so that losses due to wash outs did not fall on the contractor. The bulkheads were built and maintained under a separate contract. The work was handled in such a manner that, when a blowout occurred, the delivery of material was changed to some distant point until repairs could be effected. The dredge was in practically continuous operation, delays owing to lack of a place to deliver material aggregating not over three days for the entire eight months of operation.

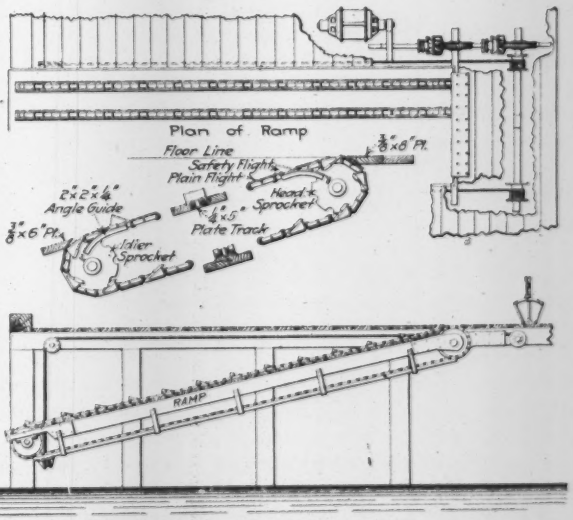


FIG. 5. DETAILS OF FREIGHT HANDLER "BOOSTER" ON ASTORIA PIER

Stormy weather and accidents to machinery resulted in interruptions amounting to about 30 days. Shifting dredge, changing pipe lines, moving pontoons, and failure of the power company to supply current caused delays equal to about one-third of the time from beginning to end of construction. The work was reasonably profitable to the contractor. The substructure up to the joists was let in one contract at the following prices:

Straight piles, $2 each, plus 10c. per ft.
Brace piles, $5 each, plus 10c. per ft.
Miscellaneous lumber, $20 per M
Caps, $15 per M
Lagging, $20 per M
Wrought iron, 5c. per lb.
Cast iron, 4½c. per lb.
All material paid for in place

The going price for timber at the mills was $12 per M for dimension stuff. Contractors at the time of letting were willing to take work at very low figures in order to keep their outfits busy. The above prices are about 20% too low, the loss being considerable on caps and lagging, making allowance for reasonable profit. The proper schedule of prices at that time would have been as follows:

Straight piles, $2.50 each, plus 11c. per ft.
Brace piles, $5 each, plus 11c. per ft.
Miscellaneous lumber, $22.
Caps, $18.
Lagging, $26
Wrought iron, 6c.
Cast iron, 4½c.

The contract prices for the superstructure were: Timber in decking and platforms, $18.50 per M; iron, 4c. per lb.; building complete above deck, $68,000. These prices were 10% too low for reasonable profit.

The contractor for the substructure was the J. A. McEachern Co., of Seattle; for the superstructure, C. L. Houston, of Astoria, Ore.; for the dredging and filling, Tacoma Dredging Co., of Tacoma. The booster was designed and constructed by Helser & Unden, of Portland, Ore. F. J. Walsh, of Newell, Gossett & Walsh, Portland, Ore., was Chief Engineer; R. R. Bartlett, Assistant Engineer in charge of designing; and K. E. Hodgman, Assistant Engineer in charge of fieldwork.

New Line of Union Pacific R.R. Through Echo Canyon, Utah

A piece of railway construction which is notable and interesting from several points of view, is the building of the second track on the Wyoming division of the Union Pacific R.R. from Emory eastward to Wahsatch, the summit of the Wahsatch Mountains, near the boundary of Utah and Wyoming. This work is through the famous Echo Cañon, and is one of the two places on the Wyoming division of the Union Pacific where the reduction of the gradients to a maximum of 0.82% or 43.3 ft. per mi. is not feasible. The other place is from Cheyenne westward to Buford.

The stretch from Emory to Wahsatch up the head waters of Echo Creek, about 13½ mi. long, which is now under construction, presents some interesting problems in railway location. This is a part of the original line located in 1864 by Samuel B. Reed, who selected the Weber and Echo Cañon route as the most feasible outlet from the Great Salt Lake Basin to the East, after many explorations and reconnoissances made under trying conditions. He went overland by stage to Salt Lake City and worked eastward.

The double-tracking of the line through this mountain pass is a part of the extensive program of betterment adopted by the Union Pacific management in 1898. The construction work was inaugurated some time later by J. B. Berry, then chief engineer of the company. A most complete study of the problem was made from the previous surveys and explorations and from new surveys. These studies were continued down to the commencement of the work on this section last fall.

A profile of the original line (with some subsequent improvements) is shown in the upper part of the opposite page and the profile of the new second track at the lower part. A study of these will prove interesting, if it is borne in mind that the new line shows great improvement over the old in other ways than grade reductions (see accompanying table); although the actual decrease in total ascent is only 17½ ft., and the saving in distance is practically nothing, the saving in total curvature is more than a half. The new line has a fairly uniform grade of 1.14% (compensated)

COMPARATIVE SUMMARY OF OLD AND NEW LINES OF UNION PACIFIC R.R., WAHSATCH TO EMORY, UTAH

Physical Characteristics	Via Present Operated Line	Via New Line	Difference Saving
Distance	16.159 mi.	15.817 mi.	0.342 mi.
Maximum curve	6° 00′	3° 00′	3° 00′
Total curvature (angle)	1,321° 43′	564° 04′	757° 39′
Total curvature (length)	7.654 mi.	5.703 mi.	1.951 mi.
Per cent. of line on curve	47.3%	36.1%	11.2%
Maximum grade, eastbound	1.77%	1.14%	0.59%
Total ascents, eastbound	905.40	887.92	17.48
Maximum grade	93.0	60.0	33.0

or 60 ft. per mi., while the grades on the old line on the approach to the summit average about 1.7% with a maximum of 1.77% or 93 ft. per mi.

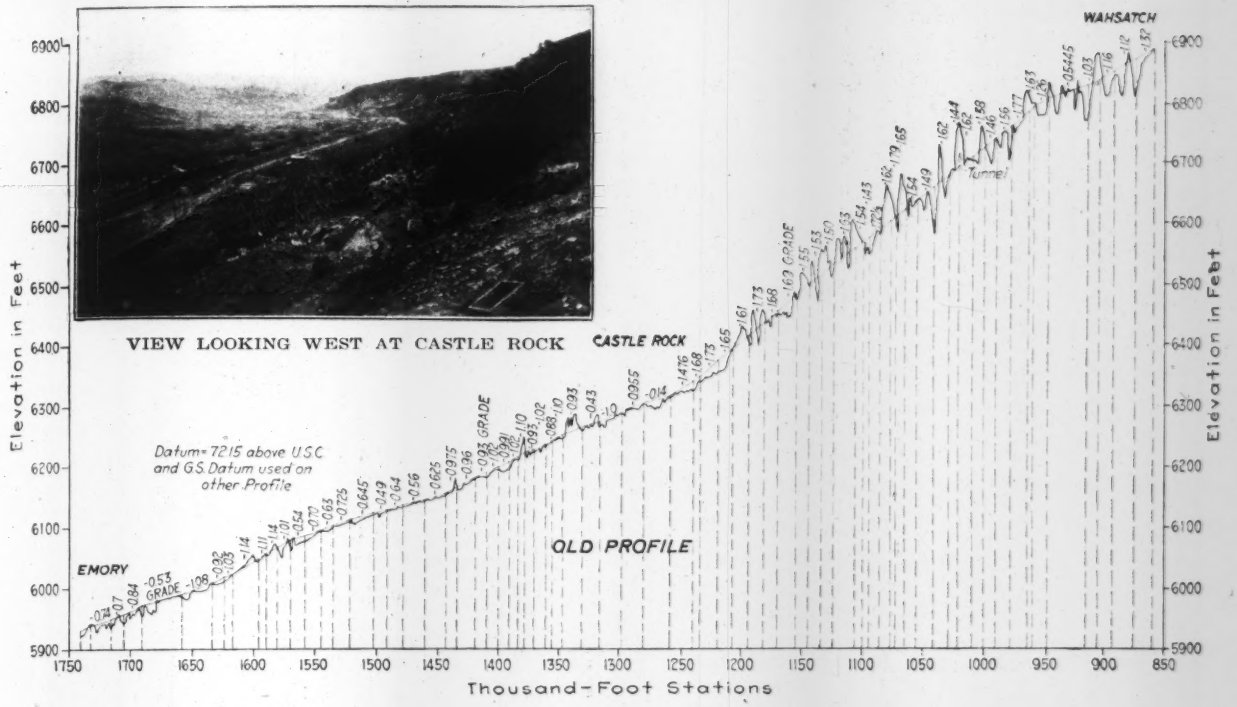
This was accomplished, however, only at large expense as may be judged from the very heavy grading on the new line as shown on the profile. There are three tunnels in this 17-mi. stretch, and several fills of a half million cubic yards or more each, one of which has a maximum height of nearly 130 ft. The cost of these 13½ mi. is in excess of $3,000,000, which proves the truth of the statement made by Mr. Berry in 1904 that the great reduction in curvature and grades would not stand as a criticism of the work of the pioneer engineers who made the original location. The original lines located under the direction of the late Gen. Grenville M. Dodge, chief engineer, was allowed by law a maximum gradient of 116 ft. per mi., yet the grades were actually held down to a maximum of about 90 ft.

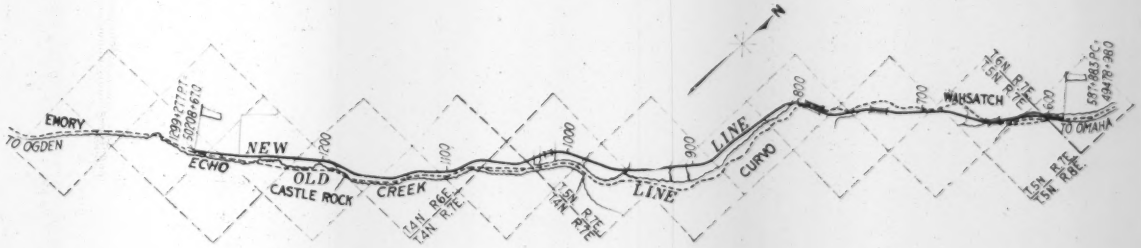
As shown in the plan the new second track is never more than 2,000 ft. from the old track. It lies mostly on the north or opposite side of the cañon, but crosses the old line at two places.

Much of the country is picturesque and in the cañon between the two tracks is a portion of the now famous Lincoln Highway. The accompanying views show the progress of the work on June 1, in the vicinity of Castle Rock, Utah. The chief engineer of the Union Pacific R.R. is R. L. Huntley, to whom *Engineering News* is indebted for the plan and profiles.

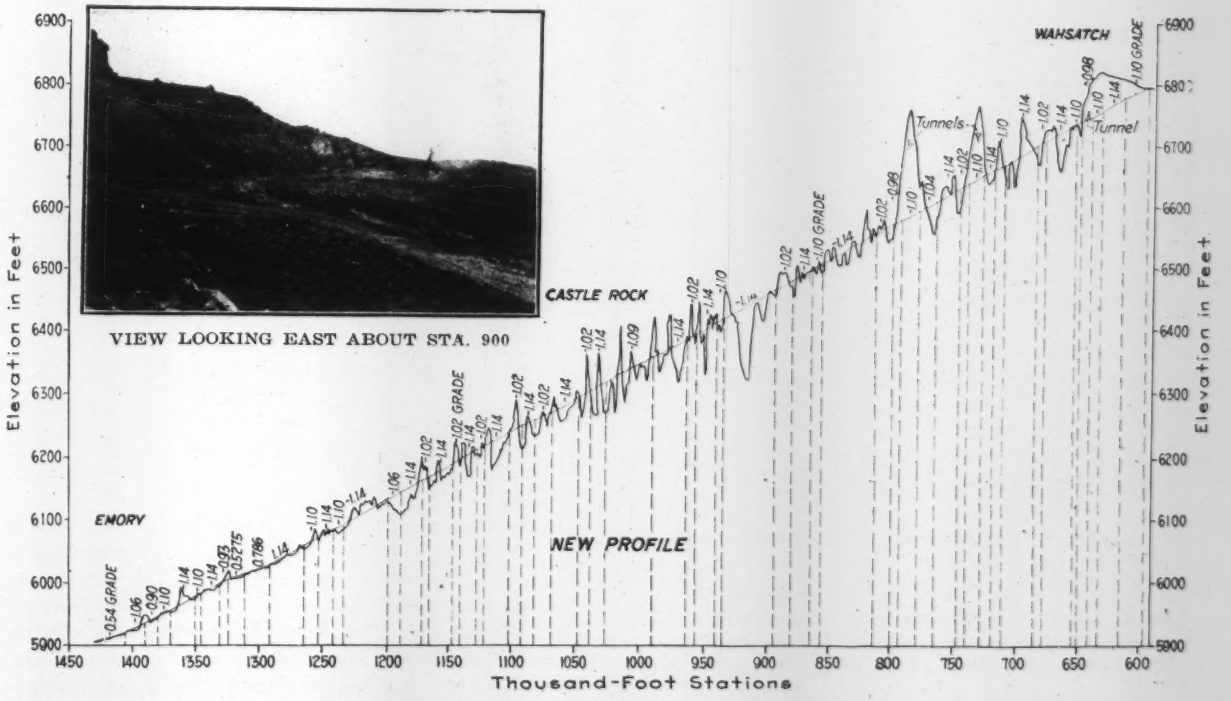
Inspection of Cast-Iron Pipe for the Chicago water-works in 1915 cost $12,450, or 27.8c. per ton for the 44,769 tons tested. The percentage of pipe rejected was 34.4%. The cost of inspection was much larger than in previous years, owing chiefly to the fact that a large number of foundries are in the field, requiring many more inspectors, while the tonnage of pipe purchased did not increase in proportion. All inspection work of the Department of Public Works is done by the Testing Division under the supervision of L. S. Marsh, engineering chemist in charge.

VIEW LOOKING WEST AT CASTLE ROCK





VIEW LOOKING EAST ABOUT STA. 900



DOUBLE-TRACKING THE UNION PACIFIC R.R. IN UTAH

Notes from Field and Office

Successful use of Cameron pump to pump grout behind tunnel lining—Drawings of falsework to support bridge while recapping piers—Florida drill barge—One cause of rust—Feeding the mixer in a tunnel through a drill hole from the surface—Concrete pavement on gumbo—Cantilever grandstand roof—A specific speed diagram

Tunnel Grouting with Pumps

By L. G. Warren*

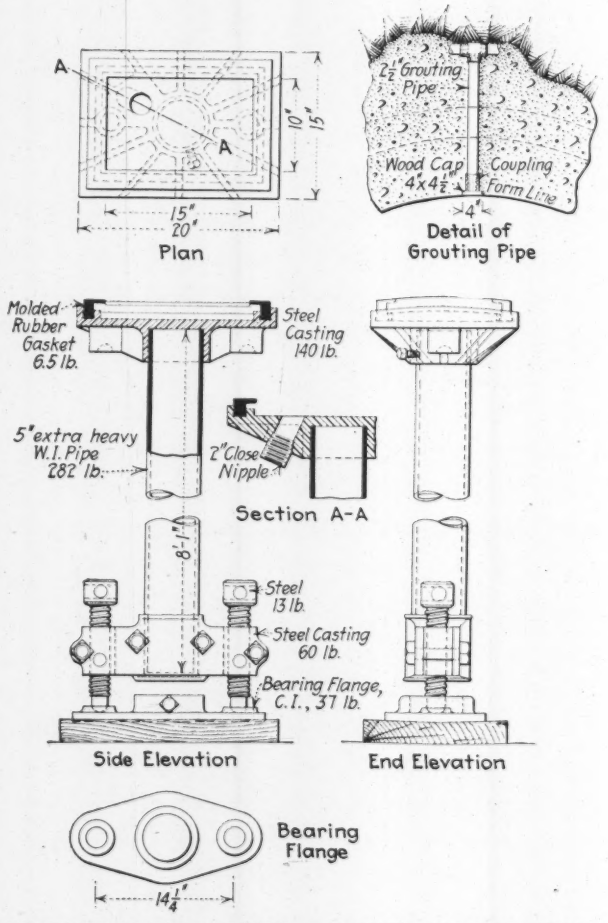
In grouting the concrete tunnel shell of the shore tunnel, Linwood Ave. intake, Milwaukee, Wis., a reciprocating pump operated by air was used with great success. The original intention was to use a Caniff grouting machine and grout proportions of 1 cement to 2 of sand. However, early in the work, in grouting back of the timber bracing and shell of Shaft 1 a trial was made of a No. 4-A Cameron pump operated by air and pumping neat cement grout. In this case the grouting behind the upper portion of the timbering entirely closed the water-bearing area and greatly aided the subsequent shaft-sinking operations, and the grouting behind the shaft concrete made the shaft absolutely water-tight. This success with the pumping method led to the almost exclusive use of the pump for grouting in the tunnel.

Several other reasons were of influence in deciding on the use of a pump in place of a pneumatic grouting machine: The pump reduces the volume of entrained air forced with the grout as compared with an air-ejection tank grouting machine; it removes the danger of disturbing and rupturing the excavation roof behind the concrete—as may occur in gravel, sand or other soft soils—by the high-pressure blast of air coming from a tank grouting machine; it secures a more uniform flow of grout; it eliminates the periodic batch placing that a single tank machine effects; and, finally, it reduces the possibility of rupturing the concrete shell with unbalanced air pressures.

The results thus far secured with the pumping of grout in the tunnel include steady flow of grout, greater area and distance covered from one grouting pipe, very small volume of entrained air, great speed of placing and the ready possibility of continuous operation.

Neat cement grout mixed to liquid consistency has been used throughout. The procedure in grouting a drift after completing the tunnel shell to the face is to place a double bulkhead of 3 in. or 6 in. of timber and 9 to 12 in. of concrete against the face, allowing this to set, and then grouting through short pipes previously set in the tunnel shell. The bulkhead, while it is an extra expense and delay, is justified by securing a high pressure of grout and assuring the sealing of the concrete shell against loss of compressed air. The high grout pressure obtained gives a very tight result.

The grouting pump was placed on the tunnel floor with an open barrel as a grout reservoir attached by 2-in. pipe to the suction of the pump. Above the barrel an ordinary mortar box was placed, with opening covered by a screen arranged to discharge into the barrel. A 1-in. water pipe discharged continuously into the mixing box. Two laborers unloaded cement in bags from the tunnel cars and dumped the cement into the mixing box. Two other laborers continuously mixed the cement and mortar by hoes. The grout as fast as mixed flowed from the mixing box into the barrel and from here was drawn into the pump and ejected through the discharge pipe. The operation thus was continuous mixing and placing. The required force consisted of the four laborers and one foreman, the latter supervising the pump operations as well as directing the laborers in handling the material and mixing.



GROUT PIPE AND GROUTING PAD USED IN MILWAUKEE TUNNEL

When leakage of grout showed through the concrete shell in the form of very small streams, they were plugged with small sharpened wooden plugs. However, as long as the leakage was clear water, it was allowed to run. Only when grout showed in the water was it plugged. Clear water always showed before the grout started to escape. When leakage developed over a large area so that plugging would not be successful, a grouting pad

*Resident Engineer, Shore Tunnel, Milwaukee, Wis.

was used. This was a board padded with waste, held up against the leaking area by a trench jack. The grouting pad gave satisfactory results.

Bran was mixed (one handful of bran to one bag of cement) with the liquid grout in the barrel reservoir to act as an aid to the wooden plugs and grouting pad in stopping leaks. The bran was a valuable agent in closing small leaks.

The maximum hourly rate of placing neat grout by the pump method has been 86 bags, and the average rate 72 bags. Placing bags behind 4,405 lin.ft. of tunnel shell has averaged 4.605 bags per foot. The maximum travel of the grout over the concrete arch from one pipe was 375 lin.ft. and the average travel 60 ft.

That the grouting resulted in a tight seal of the tunnel shell was evidenced well by a particular case in the south heading of Shaft 2. After removal of the temporary face bulkhead placed for grouting purposes the tunnel pressure dropped only one-half pound in one hour—from 19½ lb. to 19 lb.—with all compressors out of action. This occurred three days after grouting the heading, then 900 ft. from the air lock.

Grouting is begun whenever a heading shows high loss of compressed air; then the shell is completed up to the face, the face bulkhead erected and grout pumping started. With one exception, grouting has given relief from the loss of compressed air. Without the aid of grouting to seal the porous soil against excessive air loss, mining progress would be greatly reduced.

While the grout travels a long distance backward along the tunnel shell, its forward travel into the soil in the face is slight. Although grouting has been done within 20 ft. of a gravel and sand face, the grout refuses to penetrate the sand to any depth and does not penetrate the gravel more than 3 in. The sand in the gravel stops its travel almost at once.

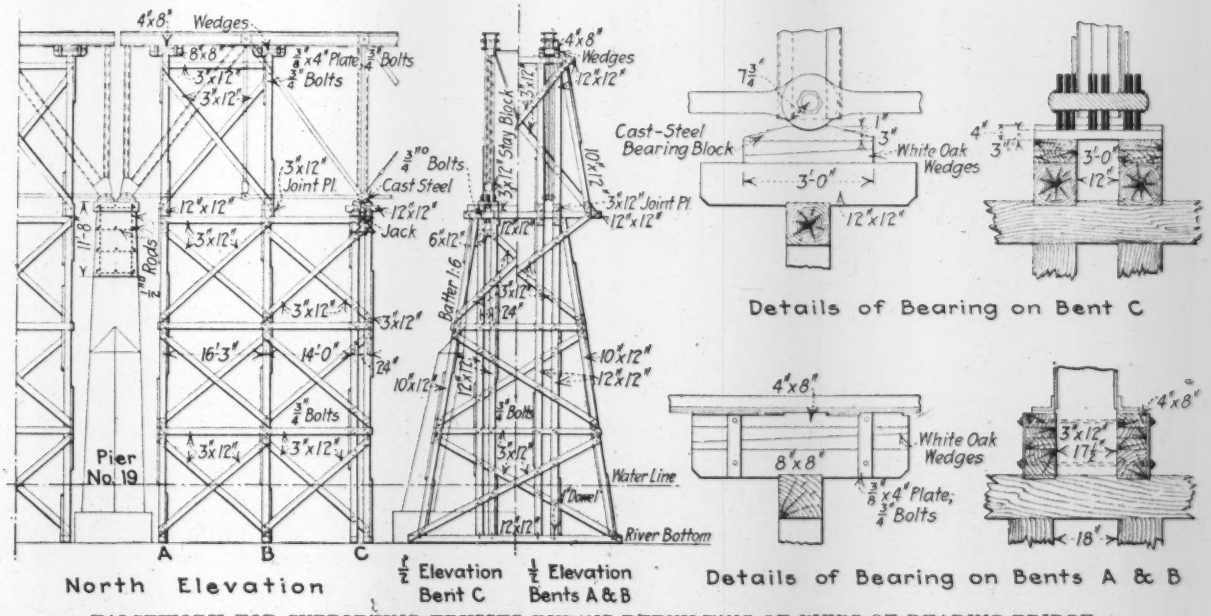
Only in two cases did the grout penetrate the face material. One of these cases was that of grouting through the arch 37 ft. from the face bulkhead. Here grouting was continued until the pump was stalled by the back pressure, and at this same time it was noticed that the timber bulkhead at the face started to distort. On advancing the heading after the bulkheads were removed, it was found that grout had penetrated the gravel and boulder deposit in the face and roof, coming down from the roof a depth of 2 ft. and traveling for a total distance of 17 lin.ft. ahead of the bulkhead. Thus the grout had a total length of forward travel of 54 ft., of which 37 ft. was behind the arch. In this case, however, the face material was proved to be very porous by the fact that previous to grouting a heavy escape of compressed air had occurred through the roof and face of the excavation. In another case the grout traveled in sandy gravel deposit a distance of 7 ft. ahead of the grouting bulkhead.

Interesting data have been secured as to the endurance of pump lining and packing in grouting with neat cement grout. Brass lining sleeves average a life of 1,000 bags of cement. Pump packing requires replacing after the pump has delivered 500 bags. A steel lining sleeve was tried as a substitute for the brass sleeve; it gave longer life than the brass and quite satisfactory operation.

Capping Old Bridge Piers Under Railway Traffic

Deterioration of the stone piers of the old single-track through Pratt truss bridge of the Philadelphia & Reading Ry., over the Susquehanna River at Harrisburg, has made necessary the capping of the weakened piers. This work has been going on for some three years and is not permitted to interfere with the normal traffic of the road.

Timber falsework built up from the river bed, as shown in the sketch, supports the trusses during the rebuilding of a pier. When the load has been taken on the falsework, the top of the pier is torn off down to sound stone. A form is then built around the top, and ½-in. reinforcement rods are placed as shown. The concrete is a 1:2:4 mixture.



FALSEWORK FOR SUPPORTING TRUSSES DURING REBUILDING OF PIERS OF READING BRIDGE AT HARRISBURG

FIG. 2. TRUSSES ON FALSEWORK DURING CAPPING

Materials are supplied by work train. This runs out on the bridge to the particular pier under reconstruction, and the materials are delivered on a platform near the top of the falsework tower.

The work is proceeding under the general direction of Samuel T. Wagner, Chief Engineer of the railway.

Drill Barge on Canal Work in the Everglades

By Charles C. Phelps*

A 60x20-ft. drill barge that assisted in the excavation for one of the Everglades drainage canals in Florida is illustrated in the view. The work was started on July 1, 1910, and was completed recently.

At first the boat carried two drills mounted in wooden towers, but later a third drill tower was added. The drills, which were operated by steam at 80-lb. pressure, are of the Ingersoll-Rand "H-64" type, stroke 8 in., cylinder 5½ in., approximately 250 strokes per min. Steam and water were supplied by means of telescopic, or slip-joint, piping.

The drill towers are moved on greased ways by means of a hydraulic ram. To move a tower, a clamp operated by a lever on the tower is made to grasp a wire rope running from one end of the ram under the drills and connecting with the other end of the ram. Each tower is equipped with a vertical hydraulic ram that is used for raising and lowering the drilling machines. Ordinarily from six to nine holes were drilled before shifting the barge.

The mud covering the rock had been removed before drilling was undertaken. It was unnecessary to keep a jet of water in constant flow to wash out the cuttings from the drill holes, but occasionally a jet was required to wash out the accumulation.

The depth of water in the canal was from 4 to 9 ft. prior to dredging and 6 to 15 ft. afterward. The drill bits varied in diameter from 3½ to 4 in. The work was single-shift, and the rate of drilling differed considerably, according to the character of the rock. It was observed, however, while making one cut 60 ft. wide through 200 ft. of solid rock that 200 holes 7 ft. in depth were drilled, loaded and blasted in 12 hr., with the three drills in operation. This figure reduces to 39 ft. of hole per hour per drill. The spacing in this case between holes was 6x8 ft., and as many as 200 were blasted at a single shot.

The contractors were the Bowers Southern Dredging Co. and the Furst Clark Construction Co.

*Ingersoll-Rand Co., 12 Broadway, New York City.

FIG. 1. BARGE EQUIPPED WITH TWO DRILLS
Working at Fort Lauderdale, Fla.

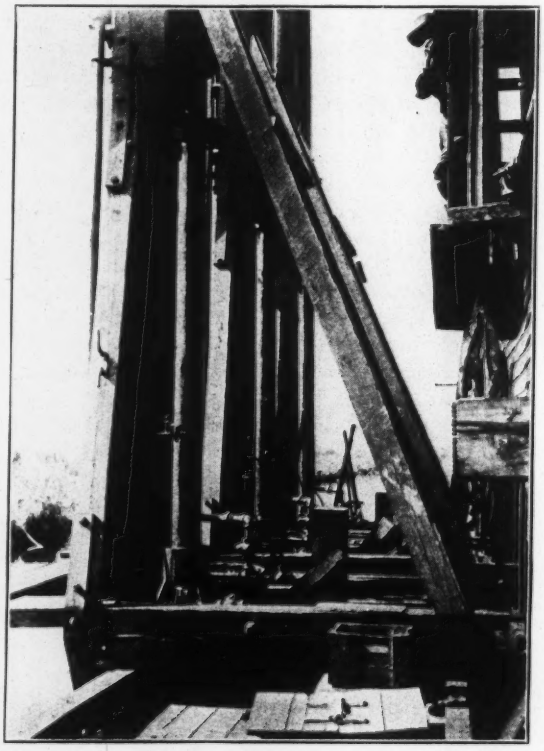
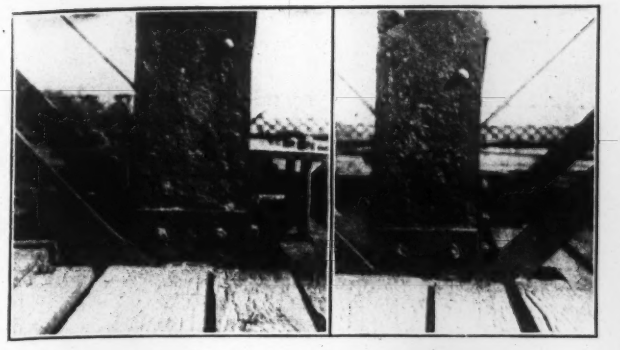


FIG. 2. REAR VIEW OF THE THREE DRILL TOWERS

Corrosion of Bridge Members Near Footwalk

The canine menace to steel bridges was referred to in *Engineering News*, Apr. 27, p. 817, in the case of a foot-bridge in Passaic, N. J.

Another example of the corrosion of bridge-truss members due to the thoughtlessness of dogs is offered in the case of a bridge across the Little Miami River, at Milford, Ohio. The rusting of two of the posts is shown in the view, the planks visible being a portion of the



RUSTING OF STEEL TRUSS MEMBERS

footwalk. It is significant that rust has not attacked the bridge to a serious extent elsewhere and that until recently two saloons were located at one end of the bridge.

This bridge carries both the highway and the interurban tracks. At the time the latter were added the channels were reinforced by a plate placed inside. At the present time the original portion is almost rusted away.

Materials Chuted Through Drill Holes to Mixer in Tunnel

By W. W. Horner*

In *Engineering News*, Aug. 31, 1916, p. 410, there was described the use of 10-in. well holes to check the alignment on the Mill Creek tunnel in St. Louis. The accompanying diagram and photographs illustrate the use which the contractors made of these holes to establish an exceptionally efficient concreting plant.

There was over 200,000 cu.yd. of solid rock removed from this tunnel. This rock was handled by motor trucks from the shaft head by two large crushing and storage plants on the railroad. From these plants stone required for the concrete lining of the tunnel was returned to the surface hoppers on the work by trucks, and the remainder was either marketed within the city or shipped out in cars.

*Engineer of Streets and Sewers, St. Louis, Mo.

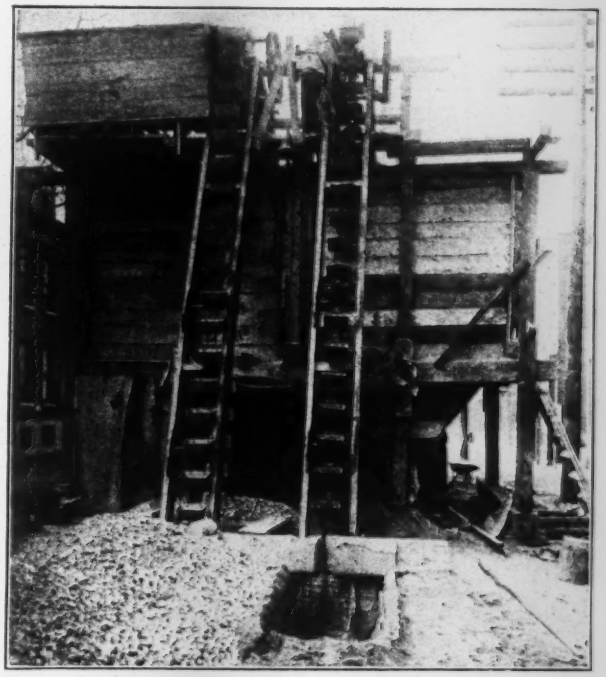
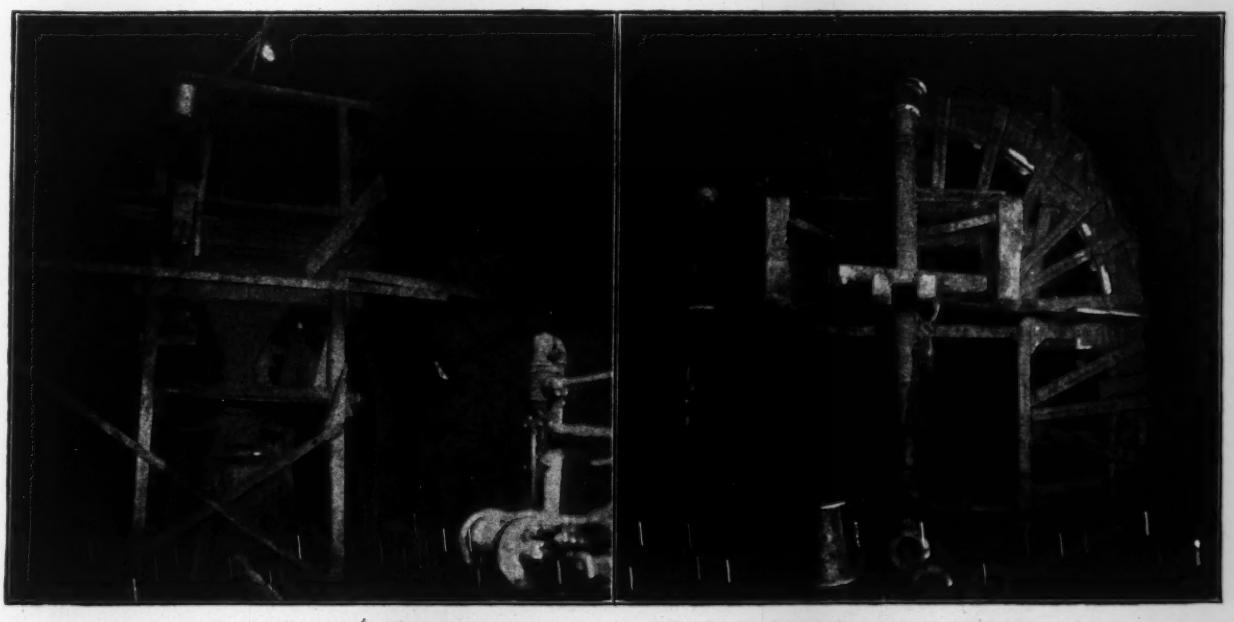


FIG. 1. MATERIAL-HANDLING PLANT OVER WELL-HOLE

As shown in Fig. 1, an automatic material-handling plant was set up over the top of a well hole, with two dumping pits, one for sand and one for stone, whence elevators raised the materials to bins. Each of the bins was hopper-bottomed, and between the hoppers were hung two measuring buckets on trunnions. The small hopper leading into the well hole was sunk into the ground between the buckets. This hopper was provided with a gate in the bottom, controlled by a lever. The labor required on the surface was one man shoveling onto the elevator,



FIGS. 2 AND 3. PNEUMATIC MIXER AND DISCHARGE END OF BLOWING PIPE

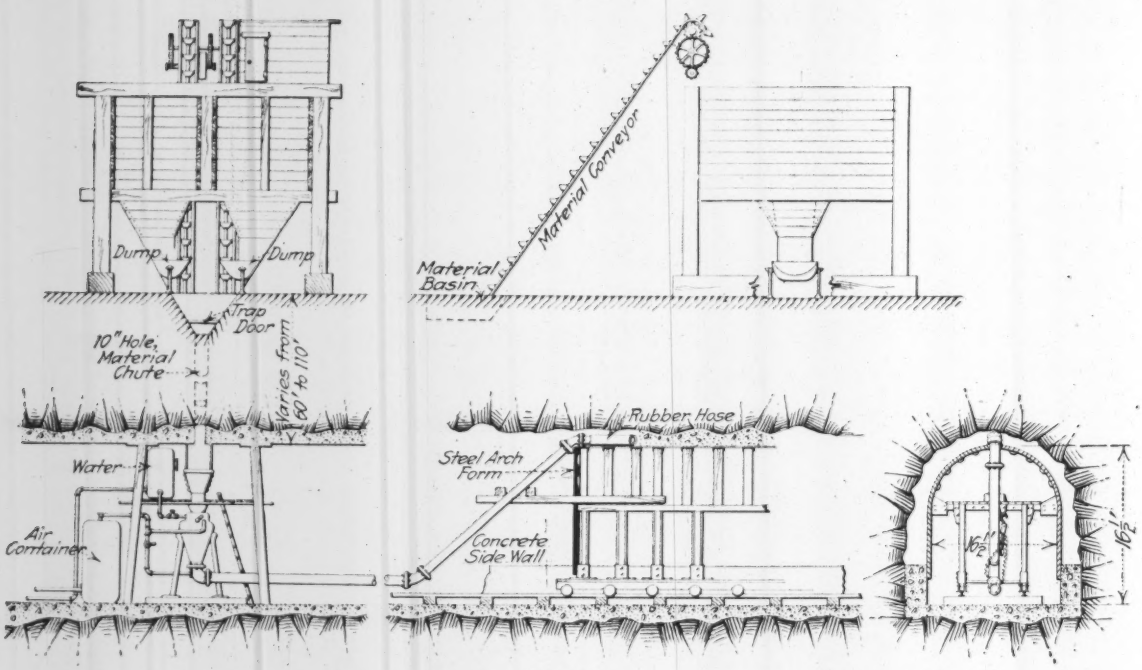


FIG. 4. SKETCH OF CONCRETING PLANT, MILL CREEK SEWER TUNNEL

one man each on the measuring buckets for stone and sand and one cementman. The last three men filled the hopper over the well hole by dumping in cement and by allowing stone and sand to run from the bins into the measuring buckets, which were simply tipped into the well-hole hopper. At a signal from the tunnel, the whole batch of material was released into the well hole.

The concrete for the invert and 2 ft. of side wall was mixed in a standard concrete mixer, located under the well in the tunnel, the batch discharged from the surface going directly into the mixer. From this mixer the concrete was pushed in small dump-cars to the point of placing, where the side walls and the floor on each side of the track were concreted and, after shifting the track to the finished floor at one side, the remaining strip in the center was placed.

All concrete for the upper portion of the side walls and the arch (which was about 75% of the whole) was mixed and placed by the pneumatic process. In this case the concrete gun was placed under the well hole, as shown in Fig. 2, and the material dropped directly into the gun hopper. Steel forms were used for the arch and the discharge pipe from the gun was carried up to the crown of the arch, ending in an 8-ft. length of reinforced rubber hose. It is interesting to note that this piece of hose, costing over $100, could stand only about a week's use.

The longest distance that the concrete was blown was 700 ft., but this maximum was due to the spacing of well holes rather than to the ability of the gun to carry the concrete. It was actually found that the concrete was much better when the forms were a considerable distance from the gun. The amount of water used in mixing had a very direct effect on the quality of the concrete. The gage glass of the water tank was therefore watched carefully. It was found also that satisfactory operation required a large air-storage tank immediately adjacent to the gun.

When using the pneumatic process the labor required was as follows: Four men on top, one man on the gun, one man on the water-supply, one man at the hose nozzle, two men in the forms distributing and ramming the concrete. The forms were 40 ft. long and required about 60 cu.yd. of concrete.

Several forms were operated from each blowing installation. The best continuous run was 19 forms, or 760 lin.ft. of arch, concreted in 13 shifts. Fig. 3 shows the form in place and the discharge end of the concrete line.

Two-Course Concrete Paving on Gumbo Soil

By Ernest L. Meyers*

Approximately 11,000 sq.yd. of two-course concrete pavement was laid in University Park, Dallas, Tex., from October, 1915, to March, 1916. The pavement was constructed with a base of 1:7 pit-run gravel concrete and with a wearing surface of 1½ in. of very rich concrete, having limestone and sand aggregates. The principal features of interest are the preparation of the subgrade and the materials used in the wearing surface.

The soil in this locality is a black adhesive loam known as "black waxy." It is sticky when wet and cracks badly when dry. If rolled when damp, it is easily compacted; but when saturated, it again swells to its original volume, causing the paving over to heave and crack badly.

To avoid the effect of this heaving action, no rolling was allowed on a wet subgrade. If the subgrade had been rolled previous to a rain, it was not again rolled, but was dressed by hand to the required grade and, when necessary, was lightly hand-tamped.

The pavement is divided into three sections as regards foundation treatment: (1) Approximately 1,300 sq.yd. was excavated 2 in. below grade and backfilled with gravel

*Meyers & Noyes, Engineers, Dallas, Tex.

and rolled. The concrete was then laid upon this base. (2) Approximately 1,500 sq.yd. of the pavement was laid upon the natural subgrade and was reinforced with No. 26 American Steel and Wire Co. wire mesh. (3) The balance of the pavement was laid on the natural subgrade without reinforcement of any kind. However, the subgrade was much better under this portion of the pavement, as rock was less than 2 ft. down.

The 1½-in. wearing surface was composed of one part cement, one part sand, one part fine stone and dust passing the ¼-in. screen and two parts of hard limestone passing a 1-in. screen. This mixture followed very closely a curve of maximum density.

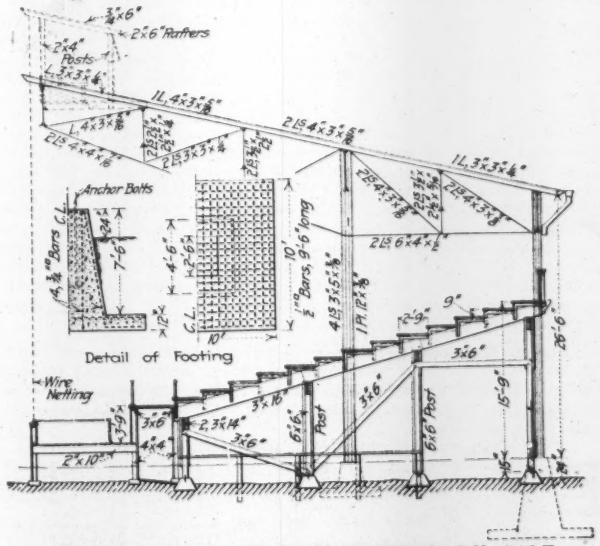
The gravel-concrete base was mixed in a batch mixer and was of such a consistency that light tamping was required to flush the mortar to the surface. A second batch mixer was used for the wearing surface, which was kept up as near as practicable with the laying of the base and was completed on all the base course before stopping work for the day. The concrete was covered with earth and kept moist for two weeks after completion.

Up to the present there has been no noticeable heaving or settlement of this pavement. Two cracks have developed—one lengthwise of the street, extending about two-thirds of the length of the 25-ft. block of pavement laid on the natural subgrade without reinforcement, and one a diagonal crack in the portion having the gravel foundation. A heavy drill derrick blew down in a windstorm and fell across the pavement at this point and may have caused this crack.

Traffic has been very light on this pavement, and as yet no definite information can be had as to its wearing qualities. Several cuts have been made in it to repair leaking water mains, and the concrete has been found to be dense and hard.

Cantilever Grandstand Roof with Tension in Posts

An interesting detail in structural steel design is the method of roofing the grandstand of the Majestic Park base-ball field in Salt Lake City, Utah. This roof is so designed that the rear posts are really anchors to keep the roof trusses from tilting on the interior supporting columns.



ROOF OF GRANDSTAND, MAJESTIC PARK, SALT LAKE CITY

The grandstand is in the form of an arc of a circle of 126 ft. 9 in. radius. The stand is 48 ft. wide and 9 truss-bays long, the chord-length of a bay being 32 ft. on the inner edge and 14 ft. on the outer edge. There are 10 radial trusses. A cross-section through the stand is shown in the accompanying illustration. Diagonal lateral bracing between the roof trusses is provided in the two end and middle bays only.

A detail of the anchorage footing of the rear post is also shown. It is of concrete, reinforced with ½-in. rods to carry the downward earth reaction on the 2¾-ft. shelf surrounding the bottom of the pedestal. This shelf is buried 7 ft. underground to provide sufficient anchorage load. The footings for the interior columns are of similar design but with reinforcement arranged for downward load.

The architects for this grandstand were Scott and Welch, Salt Lake City.

Specific-Speed Diagram for Hydraulic Turbines

The simple alignment diagram reproduced in the accompanying figure has been devised by C. D. Babcock, of Troy, N. Y., for finding the specific speeds of hydraulic turbines. It is believed to be smaller and handier than the older diagrams in use by turbine designers. The

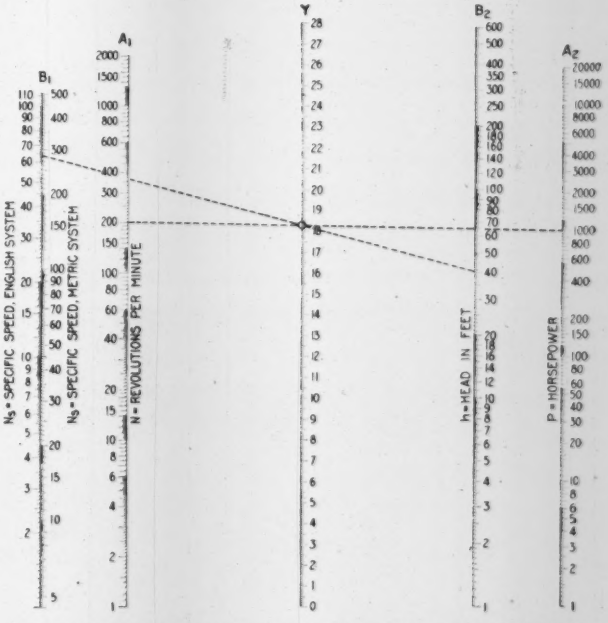


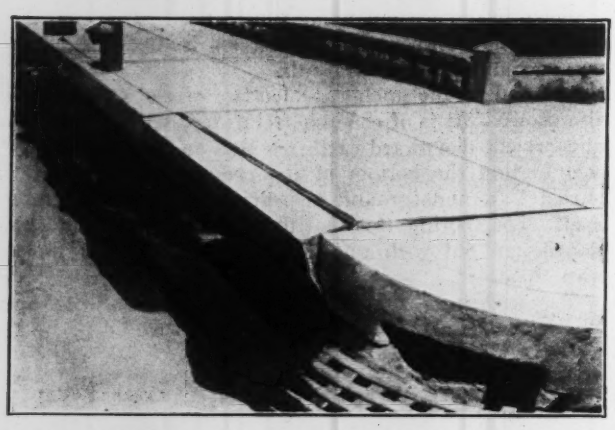
DIAGRAM FOR FINDING SPECIFIC SPEEDS OF TURBINES

results are read in either English or metric units directly from the diagram, without computation.

The use of the diagram is nearly self-explanatory; a point is found on the Y-axis, or center line, where intersects a straight line connecting the given values of horsepower and speed, A_1 and A_2 axes; this intersection point is joined to the given value of head, B_2 axis, and the line projected cuts the specific-speed line, B_1 axis, at the desired value.

FINE AGGREGATE

Expanding Concrete Breaks Curbs—The accompanying view shows a street corner in Florence, S. C. Practically at every corner in the city, where the pavement and the sidewalks reach through the full block, there is this same trouble. In some places the gutter has been pushed under the curb;



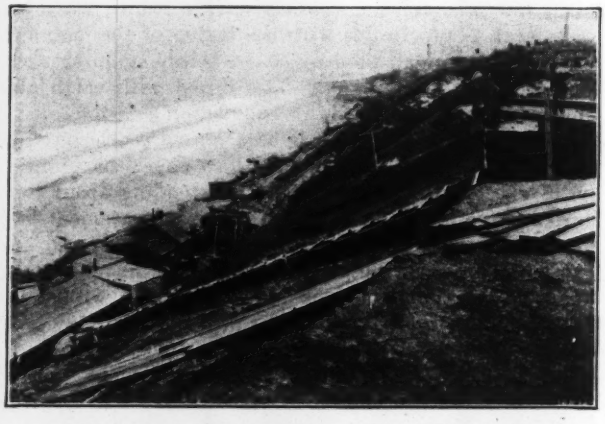
WHAT HAPPENED TO CONCRETE CURB WITH NO EXPANSION JOINT NEXT TO THE PAVEMENT

in other places the curb has been pushed back at the bottom and has cracked the cement sidewalk about 1 ft. back from the face of the curb. These sidewalks were built about 1907 and gave very little or no trouble from expansion until the summer of 1912, when they began to crack, and since then the cracking has grown worse every summer. As far as can be found at present, there were no expansion joints; and in places where the walks were full width, they were built integral with the concrete curb and gutter, all being poured at once. In 1912 the city had the streets paved with bitulithic laid on a 4-in. concrete base. There were no expansion joints, either transverse or longitudinal, in this concrete base. Since the street pavement was laid, there has been no chance for the walks or the pavements to expand without breaking something, and this view shows the result.—M'Kean Maffitt, Florence, S. C.

Jacks Make Pole-Line Work Easy—Special jacks are now being used for pulling and straightening power- and telephone-line poles by the Doherty Organization, the American Telephone and Telegraph Co. and other public-utility concerns. The accompanying illustration shows one such jack (of the "Simplex" type made by Templeton, Kenly & Co., of Chicago) in use for lifting. Digging around the pole is entirely eliminated. An I-beam base is placed beside the pole, the jack set upon it, a chain slung around the pole and pulled tight through a pear-shaped link. Only a few minutes is required for the entire operation—the record for pulling a 40-ft. pole is 8 min. Where poles have been set in concrete or in a paved street or alley, they have been pulled without damage to paving or curbing. For straightening poles the chain is not used; the I-beam base is placed a short distance from the pole, the jack placed thereon and, by means of its pivoting base, inclined at approximately 45°. The top of the rack bar bites into the pole and a few strokes of the lever force the pole into true vertical position.

JACKING A POLE OUT OF THE GROUND

Steel-Lined Material Chute—Concrete materials have to be chuted down to Shaft 2 of the Shore Tunnel of the new Milwaukee water-works intake, as the shaft headhouse lies at the foot of a bluff. An unloading platform at the top of the bluff enables cement, stone and sand to be piled or dumped and sent down the chute. The chute is at an angle of 30° and is 90 ft. long. It is 46 in. wide by 21 in. deep, and is made



MATERIAL CHUTE, LAKE PARK, MILWAUKEE

of 2-in. plank, with bottom lining of 18-gage sheet steel. The chute forks at its lower end and here has a swinging gate, so that cement can be diverted to the cement storage shed or sand and stone to the mixer platform. At the top two 3x3-ft. openings in the unloading platform give access to the chute. All materials except wet sand prove to flow readily on the 30° angle. With wet sand it is necessary to have a man to help it slide.

A Portable Plank Roadway 6 mi. in length is being constructed across the sand-hill country about midway between the Imperial irrigation district and Yuma, Ariz., as a part of the state highway being built by the California Highway Commission. These sand hills are composed of very fine uniform-grained sand similar to that used in an hour glass and so fine and dry that when a handful is picked up nearly all the sand escapes from the fist. The roadway will be 8 ft. wide with double-width turnouts every 1,000 ft., where two cars can sidetrack to allow others to pass on the main line. The roadway is built of 4-in. planks spiked to three stringers underneath. Half-inch carriage bolts are cinched up tight by means of nuts and washers under the bottom of the stringers. The individual units are 12 ft. long, weighing about 1,500 lb. each, and are rigidly joined together by bolts and iron straps. The plankway will be coated with hot road oil and then covered with coarse sand or fine gravel. A small force of men and teams will be maintained in the vicinity of the plank road to clear away small drifts as soon as they occur. Should it be found that a sand hill of considerable size is advancing across the road, a short piece of the roadway will be taken up and shifted to one side to avoid the drift.

Recent Hammer-Drill Tests showed that a 20-in. hole could be drilled in 2 min. 7 sec., using a 1¾-in. starter, and carried 16 in. deeper in 1 min. 30 sec. with a 1⅝-in. bit, the total being a 36-in. hole drilled in 3 min. 37 sec. A second test gave the following results:

	Length of Drill	Size of Bit	Depth Drilled	Time
Starter	2 ft. 6 in.	2¼-in.	24 in.	2 min. 10 sec.
Second	4 ft. 6 in.	2 -in.	26 in.	2 min. 15 sec.
Third	7 ft.	1⅞-in.	34 in.	3 min. 10 sec.
Fourth	10 ft.	1¾-in.	36 in.	4 min.
Total			120 in.	11 min. 35 sec.

These data were obtained by the Chicago Pneumatic Tool Co., whose drills were under test.

Editorials

An Engineering Problem Without a Precedent

One matter on which a good many engineers the world over have speculated, in connection with the loss of the suspended span for the Quebec Bridge, is the question whether it is within the range of engineering possibilities to raise this span from the bottom of the river, in water about 200 ft. deep. Of course, the structure, as it lies on the river bottom, is so broken and strained by its fall that even if it were recovered it would be valuable only for scrap. No one would propose using any of the members of the fallen structure in a new bridge, even though the parts might appear from external inspection to be uninjured when recovered; and the great size of the span would make it out of the question to utilize any of the material in other structures. The scrap value of the nearly 5,000 tons of steel lying at the bottom of the St. Lawrence River is high, as the bulk of it is nickel steel. But when one comes to consider practical ways and means of hoisting the fallen span from the great depth of water in which it lies, he very soon concludes that the cost would far exceed the value of the recovered material.

It would be difficult to prove that it is beyond the resources of engineering to recover the fallen steel, but to do it within limits of cost that would make it a commercial enterprise appears to be out of the question. No lifting tackle has ever been made in the world capable of hoisting such a weight as this suspended span, except the tackle that was actually in use at the Quebec Bridge for elevating it from the river to its position. In the ordinary lifting operations carried on by engineers, reliance is placed on wire-rope tackle. The most powerful hoisting machines ever built are floating cranes with a maximum lifting power of about 250 tons. The weight of the Quebec suspended span, however, was about 20 times as great as this.

As will be recalled, the chains by which the span was being hoisted into position were made from plates 30 in. wide and 1⅛ in. thick. Eight of these plates were required to lift one end of the bridge. Evidently chains of at least equal strength would be required to hoist the fallen span from the water. Of course, chains of such strength could be made, and means could perhaps be found for securing them to the hull of a vessel, although the problem of applying so huge a concentrated load to a floating structure is in itself unprecedented. The difficulty would then arise, however, of attaching the lower end of the chains to the wrecked truss. It is conceivable, of course, that something might be designed in the shape of a gigantic hook or grapple that might be maneuvered into position under some joint of the wreckage with the aid of divers, even at the great depth at which they would have to work. When it came to the actual lifting, however, it is probable that the whole mass of connected steel, or the main trusses at least, would hang together as the lifting proceeded until failure occurred in some overstrained joint, and then a large part of the imposed load might be suddenly released as breakage occurred. The stresses and shock that this sort of work would induce in the gigantic lifting tackle may be imagined.

The Engineer, of London, in discussing the accident remarks:

> The span has in all probability fallen more or less in position; and if it is found on inspection to be indeed worth salving, it is not impossible that the arms of the cantilevers may serve as cranes to raise it from the bottom.

Those who experienced the shock and vibration that occurred on the cantilevers when the load of the suspended span was suddenly released will look with little favor on the above suggestion.

Apparently the only feasible plan for recovering the metal in the fallen span would be to find some means of cutting the wreckage into pieces within the capacity of ordinary lifting tackle. Were the wreckage above water, this might be done by the oxyacetylene torch and possibly by the use of high explosives, but in the great depth of water where the wreck lies and realizing the extent to which the parts are tangled and bent by the fall, there seems little prospect that any plan for cutting apart the wreckage could be made practically successful.

The above by no means exhausts the list of difficulties that would have to be overcome in order to recover the lost span; but it indicates at least the small prospect that anyone will undertake the task.

A New Method of Finishing Concrete Roads

A well-known engineer interested in road construction spent a week's time and traveled nearly 3,000 mi. to inspect concrete-road construction in progress in half a dozen different states, including a number of jobs that are supposed to represent the latest and best practice. His report upon his return was that the most important development in concrete-road construction that he had anywhere seen was the method of smoothing off the concrete surface with a canvas belt, in use on the roads of Wayne County, Michigan.

An article in the last issue of this journal described this process as now used, but the idea is so simple that it almost explains itself. It will be obvious to any engineer experienced in concrete-road construction that this method of finishing represents a very considerable saving over the standard method of floating the surface with hand floats from portable bridges. This saving in expense is important. In many localities the question what type of road to adopt is simmering down nowadays to the question whether it is cheaper and better to build a concrete road or to lay a concrete foundation and then take the money that would be required for the extra cement and extra labor necessary to make the concrete foundation good enough to stand traffic on its surface, and by adding a little more money pay the cost of an asphalt surface on the concrete foundation.

There is another reason why the canvas-belt method of finishing may prove of great importance to the concrete-road industry. With the present mode of finishing concrete roads by hand floating, small inequalities are almost inevitably worked into the surface, which produce a slight shake and jar in a car running over the road at high speed, so that the road is not quite as pleasant for automobile pleasure traffic as is a first-rate bituminous macadam road or a good gravel road, when either of these latter roads is in perfect condition. If, however, concrete is mixed fairly dry and is formed to the true cross-section of the road by the strikeboard, it should then become possible with the canvas-belt method of finishing to produce a uniform surface on the finished road, free from humps and hollows. The surface ought to be durable, moreover, for any surplus water or laitance brought to the surface by the friction of the canvas belt should drain off, so that the road will set hard and firm.

Time To Stop Road Destruction by Motor Trucks

At a convention of one of the national road associations last winter, a speaker representing motor-vehicle interests declared that it was the business of engineers to build roads so substantial that motor vehicles could run over them without any limitation of speed or load. Unfortunately for the taxpayers, this extreme declaration of policy is actually being carried into practice by some builders and users of motor vehicles. Almost without exception they are now at liberty to haul over public highways vehicles of any weight they choose, run at any speed that the combined effect of the motor and the grade will produce.

Attention has frequently been called in these columns to the millions of dollars of damage that is being done to expensive roads by motor trucks, but the flippant answer of the truck builder and truck owner has been that the roads should be built to stand the traffic. The absurdity of this idea has been repeatedly shown; but a complete and final demonstration of its impossibility is furnished by the article published elsewhere in this issue describing the destruction, within the short period of four months, of a modern granite-block pavement in New York City by the impact of very heavy steel-tired motor-drawn vehicles run at high speeds. Of course, everyone knows that it is impracticable as a financial proposition to lay granite-block pavements on country roads at a cost of $1 to $5 per sq.yd. The experience in New York elsewhere described, however, shows that even if this were a financial possibility, such roads would not fulfill the requirement referred to above—a road that would stand traffic of any weight at any speed.

It must be obvious that if cities and counties and states are to escape financial bankruptcy as a result of the enormous expense of road maintenance, they must take drastic measures to stop the destruction of roads by motor-truck traffic. Limitations to weights and speeds must be drawn somewhere; and enough experience has now accumulated regarding the destructive effect of motor-truck traffic so that it is entirely possible to frame a law that will protect from undue injury the roads which the taxpayers furnish the money to build and maintain, and that at the same time will not interfere with legitimate use by motor vehicles.

Three years ago an ordinance was introduced in New York City requiring licenses to be obtained by every vehicle using the streets of the city, the license fees being graduated according to the load in pounds per inch width of tire. For vehicles carrying loads per inch width of tire of 750 lb. or less, the license fee was $1. The rate then rapidly increased so that for loads of 850 to 900 lb. the license fee was $12, and for 950 to 1,000 lb. the license fee was $50.

For vehicles designed to carry loads per wheel of 6,000 to 10,000 lb., graduated license fees were fixed varying from $75 for wheel loads of 6,000 to 6,500 lb. up to $1,000 for wheel loads from 9,500 to 10,000 lb. The ordinance was not pressed for passage because of the opinion rendered by the Corporation Counsel that, on account of the special regulations of motor-vehicle traffic put in force by the state, the city could not enforce such an ordinance.

This, however, it should be noted, was after all only a lawyer's opinion. The pressure of public necessity is insistent. City administrations everywhere are face to face with the great difficulty of obtaining sources of revenue to keep pace with the constant increase in expenses. A system of graduated license fees on vehicles using the public highways could compel those who use the roads to pay for the wear and tear they cause, and at the same time so penalize the use of motor trucks of exceptional weight, speed and destructiveness that it would be no longer profitable to operate them.

Meters To Save Philadelphia

For a half century the successive engineers responsible for the water-supply of Philadelphia have pleaded—one might almost say fought, bled and died—for the adoption of measures to stop the waste of water for which Philadelphia has been notorious. Their efforts now promise to bear fruit, as may be seen by the statements in the last part of this issue.

It appears that the intense opposition to meters that has been manifested by the public and reflected by Councils, has at last given way to conviction that meters alone will conserve the present supply of water that is being purified by works built at vast expense with the popular understanding that they would be adequate for years to come.

The method to be pursued at Philadelphia is the obvious remedy for conditions that exist not only there but in other cities. Large consumers are to be compelled to buy water through meters. Small consumers will be forced to do the same if they waste water, and will be encouraged to adopt meters in any event, through a proper adjustment of charges for unmetered and for metered water.

Simplicity would dictate the wiping out of the long schedule of flat rates and putting all consumers on a metered basis as soon as meters could be secured and adopted; but in dealing with the mass of small consumers, including all in the domestic class, it is best to make haste slowly. In the end self-interest will prevail, but of course the people must be shown what their true interests are. With the large consumers, few in number but using and wasting a huge total volume of water prompt compulsion is imperative.

Canadian Engineers Object to Appointment of Aliens

Engineers who have had the responsibility of serving on the governing board of a national engineering society can usually recall instances when measures were brought before the board, urged for passage by some specious argument and finally adopted; yet afterward the majority of the members, on sober second thought, would regret the action that had been taken.

It is probable that some such record could be made in connection with the extraordinary circular recently issued by the Canadian Society of Civil Engineers protesting against the appointment of Prof. George F. Swain as engineer of the commission that is to advise the Canadian Government on certain matters of railway policy.

The protest was of course not made on any personal ground. Professor Swain is an engineer of international eminence and is a member of the Canadian society. That society has made its public protest on the ground that the appointment should have gone to a Canadian engineer. It says:

> We wish to record our strong condemnation of the policy of placing in the hands of aliens the engineering work of a commission appointed by the Canadian Government to investigate Canadian railways for which the Canadian community has paid.
>
> The inferences to be drawn from the employment of aliens in the above connection are that the Federal Government considers:
>
> 1. That the Canadian engineers who built the railways are not competent to report upon them.
> 2. That the Canadian universities, in many cases enjoying Government subsidies, are not producing competent engineers; and
> 3. That the Canadian Society of Civil Engineers, although embracing a membership of about three thousand, is not considered worthy of consultation on an important engineering question.

The circular then proceeds with the statement that Canadian engineers probably do not get such appointments because they do not assert themselves nor demand recognition and that the council of the Canadian society proposes to initiate a campaign to secure for Canadian engineers due recognition.

The Canadian Society of Civil Engineers is an organization which has had a splendid history. Included among its membership are many men whose record of important work achieved entitles them to rank with the leaders of the profession in the United States or any other country. Unfortunately, there has been in the society more or less of a tendency to make the organization's main purpose the monopolization of the engineering business. We need only refer to the legislation which the society has secured in Quebec, limiting the practice of civil engineering in that province to members of the society. Such legislation stands on a par with that attempted by some of the local engineering societies in the Western States, whereby a system of state licenses to engineers was to be established, the license fee being fixed at $500 for engineers resident outside the state.

It is almost unnecessary to say in these columns that the building of geographical fences in the engineering profession is against its best interest as well as against the best interests of the public. What the public wants in its engineering work is the man who can deliver the goods, regardless of his nationality or the place where he may happen for the time being to have his residence. When it is attempted to lay down the rule that engineers should be employed because they live in a certain city or state where the work is to be done, we are practically accepting the theory that the work is done to furnish jobs for those who want them.

It is of course true that at times when a professional adviser has to be chosen there is a certain tendency to overlook the merits of home talent and choose a man whose reputation is magnified because he comes from a great distance. Protest against errors of that sort is justifiable; but any organization of engineers should beware of placing itself before the public as seeking to claim appointments for its members. There could be no surer way of forfeiting public confidence and respect.

Our contemporary, the *Canadian Engineer*, takes a sound view of the matter when it says: "The Canadian engineering profession cannot afford to be too narrow in its views of such matters. It cannot adopt the closed-shop method."

Should Street-Car Bridges Be Designed for Derailment

Typical accident conditions existed at the site of the West Third St. bridge wreck in Cleveland. A steep down grade with a sharp curve at the foot—this combination has caused many a wreck. To Cleveland citizens the West Third St. hill was familiar enough to make them forget the probability of accident, and a long record of freedom from mishap gave additional reassurance. But the well-known law of chance, that the probable event will very likely happen some time, even if long deferred, finally operated, by means of a motorman who let his car get out of control.

What made the Cleveland accident bad was the presence of the bridge at the danger point. This bridge was vulnerable, not because it was old, and light, and probably in great need of renewal, but because it was an ordinary, unprotected bridge. Doubtless both the city and the street railway people knew—or might have known if they stopped to think—that a car accident on the hill would be sure to wreck the bridge and thereby multiply the seriousness of the accident. They put their reliance on preventing car accidents; when the right time came this reliance failed.

Railway analogies, drawn from many decades of experience, are illuminating with respect to safe practice in rail transportation. They put guard rails on bridges for instance, rather than rely on absolute freedom from derailment. Where viaduct columns are placed near railway tracks, they build fender piers around the foot of the bent, to make the viaduct safe even when a train wreck occurs directly under it. So in bridge design, they have developed their floor details and various other elements of the construction largely on the basis of derailment requirements.

It may prove feasible to base the design of a bridge like the West Third St. structure on derailment conditions as the governing consideration. A distinct gain of safety might be secured by building such a bridge that even a runaway car could not break it down—to fall, perhaps, on a train loaded with people, just then passing under it. It would be rather beyond precedent to go to such refinement and expenses in a mere street bridge; but would it not make a safer bridge?

Letters to the Editor

A Thin Arch Dam in Australia

Sir—In your issue of Feb. 10 there appears an article on the Upper Otay Dam, San Diego, Calif., describing the passage of the recent floods over that structure. The article states that "There have been constructed in Australia, to form irrigation reservoirs, some arch dams that are even thinner than the Upper Otay dam." The Medlow Dam, New South Wales, designed under the direction of the late L. A. B. Wade, is believed to have the thinnest profile in the world, the thickness at a depth of 62 ft., being only 8.96 ft. This dam, however, is built in a narrow gorge, the radius being 60 ft., and the maximum stress on the concrete being only 12 tons per sq.ft.

A concrete arch dam designed by the writer, and built under his general supervision, was recently constructed on Sorell Creek, Tasmania, Australia. The dam has a crest length of 155 ft., and an upstream radius of 110 ft. The thickness is 2 ft. at the top and 6 ft.

THE SORELL REINFORCED-CONCRETE ARCH DAM IN TASMANIA

at a depth of 30 ft., and the stress on the concrete is 15 tons per sq.ft. The height from crest to bedrock is 50 ft., the lower 20 ft., however, is very short and is practically a cut-off wall carried through a dike of decayed rock. A raised crest in the center limits the passage of floods to a length of 50 ft. at either end of the dam.

The capacity of the reservoir is only 66 acre-feet, and the dam was just completed and the concrete still green when heavy rains fell. The reservoir was filled in three hours and a depth of 2½ ft. of water flowed over the bywashes for two days without injury to the structure. During the next three months several floods passed over the dam. The design stress of 15 tons per sq.ft. is conservative, but was adopted as neither foreman nor men with previous experience of this class of work were obtainable.

The arch dam has been used in several cases in Australia as a solution of foundation problems. When a short length of faulty rock occurs a short length of arch dam has been built connecting two wings of gravity type, a cut-off being carried down to sound rock beneath the arch. Where the site is suitable the writer regards the arch dam as a most satisfactory type, as danger from uplift and sliding are practically eliminated; moreover, greater economy is often obtainable.

W. NIMMO,
Engineer-in-Chief's Office, Department of Public Works.
Hobart, Tasmania, Aug. 21, 1916.

Why Put a Gravel Cover on the Concrete Floor of a Bridge?

Sir—In answer to your correspondent C. E. V.'s letter on p. 468 of your issue for Sept. 7, under the heading: "Why Put a Gravel Cover on the Concrete Floor of a Bridge?" I will state that the advantages are as follows:

1. The gravel covering is less expensive than the extra thickness of concrete floor and weighs no more.

2. Troweling the top of the slab is not necessary when a gravel covering is to be placed, making a further saving in cost.

3. Chuck holes at the end of the bridge are avoided where the surface material on the bridge is the same as that on the road. Where two different types of surfaces meet, chuck holes will develop under traffic.

4. The gravel covering is of great assistance in properly curing the concrete slab.

I have not as yet seen a single case where the gravel covering raveled under traffic. It wears out no faster than the surfacing on the road and can be maintained along with the road-maintenance work.

C. E. NAGEL,
Deputy State Engineer.
St. Paul, Minn., Sept. 15, 1916.

Types of Road Surfacing for Loose-Sand Foundation

Sir—I note in *Engineering News* of Sept. 28 an inquiry relative to the construction of a concrete road on a loose-sand foundation. I would like to add another type of road to those suggested in your tail-note. If clay is not available, I would suggest a crushed-stone or macadam road on a straw carpet.

To build a road of this type, the sand subgrade is first shaped to the desired cross-section, with side drains of ample capacity. After the subgrade has been crowned and smoothed, a carpet or mat is prepared of baled straw, to a depth of 4 to 5 in. Baled straw is used rather than loose straw, as the mat can be more readily laid. The first course of 2½- to ¾-in. crushed stone is then placed to a depth of 6 in. The second course consists of 3 in. of ¾-in. or finer stone screenings. The courses may be rolled, but a light roller should be used to avoid "waving."

The straw carpet serves as a foundation for the stone until the road is bonded. With the perfect drainage that a sand subgrade offers, the straw will not rot until the stone has cemented and bonded together. While this type of road is not fitted for trunk-line traffic, it offers a solution for the problem of a moderate-priced road on a loose sandy soil.

I have seen roads of this kind built of crushed limestone in the white-sand soil of northern Michigan; it not only makes a fine smooth surface but wears well, and maintenance charges are low.

The total cost of a road of this type, including grading, should be between $3,500 and $5,000 per mi., depending on width of metal, length of haul for material, labor costs, etc. R. L. LONGSHORE,

Assistant County Engineer, Adams County, Indiana.

Decatur, Ind., Oct. 2, 1916.

[The use of straw or grass mats on loose soils is nearly as old as macadam-road construction. The purpose of the mat is merely to keep the broken stone or gravel surfacing from being rolled or worked into the subsoil, before the macadam surfacing is bonded into a unit. N. S. Shaler, in his "American Highways" (1896), recommended muslin cloth as a substitute for straw in certain instances.—Editor.]

Long Island Concrete Roads

Sir—In looking over your remarks following the letter in regard to the concrete roads on Long Island on sandy soil in *Engineering News*, Sept. 28, p. 616, you make mention that the concrete is poor and shows wheel tracks.

I was on Long Island a few weeks ago in company with the engineers of the Highway Department and noticed the ruts. They are caused by driving in the same track with cars equipped with tire chains, during the winter when snow is on the road; and it is a good road that will not show marks under that treatment, and with the speed they drive down there. OSCAR HASBROUCK,

Engineer of Convict Labor.

Hudson, N. Y., Sept. 29, 1916.

Are Boats for Lake and Ocean Traffic Practicable?

Sir—Referring to your review of the report of Sanford Evans on the Great Lakes traffic, in *Engineering News* of Sept. 28, toward the end it is stated that the Lake vessels might be operated on the ocean during the winter. We considered this matter in connection with the design of the Georgian Bay canal, and it is still a very interesting subject. It is generally considered that the highly specialized ore boat used on the Lakes is too long, too lightly built and not of deep enough draft for the ocean. The engines astern and ballast-tank system would not quite suit, and the condensing apparatus would have to be different.

On the completion of the Soulanges canal in 1900, several Clyde-built boats 250 ft. long, 43 ft. beam and 14 ft. draft came out to ply on the Great Lakes. The first difficulty was that the steering gear was too slow for canal and Lake channel work; next, the hatches were not spaced to suit the loading and unloading machinery of Lake ports. The wage rate of the salt-water crew was less than half the rates paid on the Lake; consequently, the men promptly deserted. The rules of navigation on the Lakes are different and also the bell signals, while the modernized Lake chart might puzzle some of the old sea dogs.

In general, the Lake traffic is a highly organized and highly specialized business; 80% of it consists of carrying iron ore from Superior to Erie and coal back. The ore carrying, however, is materially different from the system used in the ore traffic between Spain and Great Britain. The old "hog" type of vessel was tried on salt water, but proved very unpopular with the crews. The seas pounding on the whale-back deck prevented sleep and also regular meals, and eventually the construction was found to be too weak.

The St. Lawrence indents America as deeply as the Mediterranean penetrates the eastern hemisphere, and ocean vessels must some day ply regularly up to Superior. The St. Lawrence valley is surely destined to be the greatest traffic artery in the world. J. R. COUTLEE,

Engineer-in-charge, Ottawa River Storage.

Ottawa, Ont., Oct. 2, 1916.

Vocational Guidance for the Engineering Student

Sir—Commenting on the article in *Engineering News* of Aug. 31, by Prof. W. M. Wilson, on "Misfits in Education" and on the accompanying editorial, the writer agrees with Professor Wilson that the strictly engineering work should be postponed to at least the second year in college; but, with the editor, he thinks that Professor Wilson's remedy is not radical enough.

Some colleges already have a uniform course for all freshmen and do not begin to take the department work until later in the college course. The writer agrees with Professor Wilson that some courses should be introduced into the schedule giving the characteristics and requirements of the professions. At least one college has done this to some extent in the form of smoker-talks and lectures from business and professional men as well as members of the faculty.

It is not proposed to attempt a new solution of the question of misfits in education, but to call attention to a system which has been in successful operation for about 45 years, with slight modification, and which the writer believes tends to eliminate a great many of the misfits before it is too late for them to turn to some other kind of work.

Instead of beginning the engineering work in the second collegiate year it is far better from all standpoints to begin the engineering work in the fourth, or senior, year. The system which has been adopted and found most successful in educating engineers (not experts in some narrow engineering field) is based on three years in a college of arts and sciences, a fourth year substituted for the senior year in the college and devoted entirely to the fundamentals of engineering, and a graduate year devoted to more advanced engineering work. During the three preparatory years in college, courses in physics, chemistry, drawing, descriptive geometry, mathematics, etc., are required, the remaining time being devoted to cultural subjects—English, history, economics, languages, etc., to fulfill the college requirements for graduation. A grade is required for entrance to the

engineering school which is slightly higher than the average college grade, and an entrance examination is also required, thus giving an opportunity to pick the engineering students to some extent.

As a result, less than half of the men who start out in freshman year to be engineers reach the engineering school. Those who do not reach it have not been narrowed by their college work, but can take up any other course for which they are better fitted. Of those who take the fourth year in the engineering school and are graduated from the college, about three-fourths return for the graduate year. There are about four months between the two years' work in which the prospective engineer can get a great deal of outside experience, and many men stay out a year or more before returning for the graduate year in the school.

In addition to the engineering school there is connected with the institution a School of Administration and Finance, requiring three years of college-preparatory work, and a medical course requiring two years' preparation, so it may be seen that the system is very flexible.

Experience in teaching in a prominent state college typical of the usual four-year course and in teaching under the system above described has proved to the writer that specialization should never be attempted in the four-year technical college course, but only the very fundamentals of engineering should be taught. This gives none too much time for the essential foundation work. Any man who wishes to specialize should do so in a graduate course.

In addition to the advantages of gaining picked men better fitted for their life work, other advantages of beginning engineering work in the fourth year are: Freedom from athletic and other diversions; a better *esprit de corps;* a greater willingness to work, on the part of the student, together with the ability to do more work and to do it more thoroughly; opportunity to eliminate the one hour a week course (the abomination of abominations) and to make a schedule of courses giving better sequence and fewer courses at a time; opportunity of from four months to two or three years of practical experience before taking the final year; and lastly, opportunity to take more cultural and general studies.

In regard to the last point, every engineer who has not done so should study one of the reports on engineering education, by Dr. C. R. Mann, of the Carnegie Foundation, wherein he states the fundamental defect of engineering education at the present time to be narrowness, particularly with respect to English, economics and other cultural subjects.

SYDNEY LEE RUGGLES,
Instructor, Thayer School of Civil Engineering.
Hanover, N. H., Sept. 19, 1916.

Petition by the Unorganized Railway Employees

Sir—With reference to the railway wage controversy, the unorganized men have called for a report of how their petition to the President and Congress was handled by Mr. Walden and me, who are heading the movement, and how it was received at the White House. So we are issuing the inclosed statement to them.

I may add that the 80% are very much opposed to the legislation as enacted and to President Wilson's recommendations to Congress, which altogether ignore their rights, and expect to present at the next session of Congress a strenuous appeal for a full and just investigation of the whole railway wage situation.

ROBERT T. FRAZIER,
Assistant Engineer, N., C. & St. L. Ry.
608 So. Dearborn St., Chicago, Oct. 7, 1916.

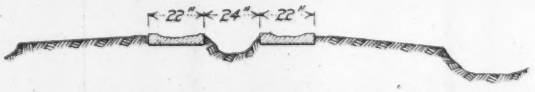
[The statement accompanying Mr. Frazier's letter recites that the petition signed by 105,000 railway employees asking that legislation be enacted to provide for arbitration of all differences between railway companies and their employees was taken to Washington by Mr. Frazier and Mr. Walden who daily visited the White House and sought to see President Wilson during the three weeks while his time was chiefly given over to the railway situation. They were unable to see the President and on Aug. 30, following his message to Congress, Mr. Frazier wrote him advising him that the petitions he bore had been signed by 111,000 railway employees, and that if the legislation recommended by Congress was enacted, the remaining 80% of the railway employees must of necessity organize and present their demands upon the railways.

On Aug. 31, the President replied regretting his inability to grant a personal interview and stating that his recommendation of legislation affecting trainmen only was "because of the lack of constitutional power to deal with any of the employees except those actually engaged in interstate transportation."—Editor.]

Use of Paved Wheelways on Roads of Holland

Sir—Paved wheel-track ways on roads, similar to those proposed by F. T. Warner on page 469 of your issue for Sept. 7, have been extensively used throughout the marshy sections of Holland. They are in great favor with the rural population, for the soft center path makes them ideal roads for one-horse vehicles. These wheelways have been in existence for at least 100 years. Some of them were built by order of Napoleon, who wanted them for cannon transportation in case of an English-Russian invasion in the north of Holland.

The roadway wears rapidly in the center, and the soft sides recede from the hardened tracks; therefore the



BRICK-PAVED WHEELWAYS IN HOLLAND

roads are not suitable for swiftly traveling motor cars. The deep gutter formed between the tracks is usually filled with water, notwithstanding attempts at thorough drainage. A typical cross-section of the roads after a few years' use is shown in the accompanying sketch, without exaggeration.

It is not at all necessary to make the trackways of the thickness proposed by Mr. Warner, as a 4½-in. layer of hard-burned bricks has withstood the moderate vehicular traffic of Holland for a lifetime.

On agricultural estates throughout the East Indies I saw roadways made of two concrete slabs incased in structural-steel frames to make the trackways transportable.

JAN SPAANDER.

Brooklyn, N. Y., Sept. 9, 1916.

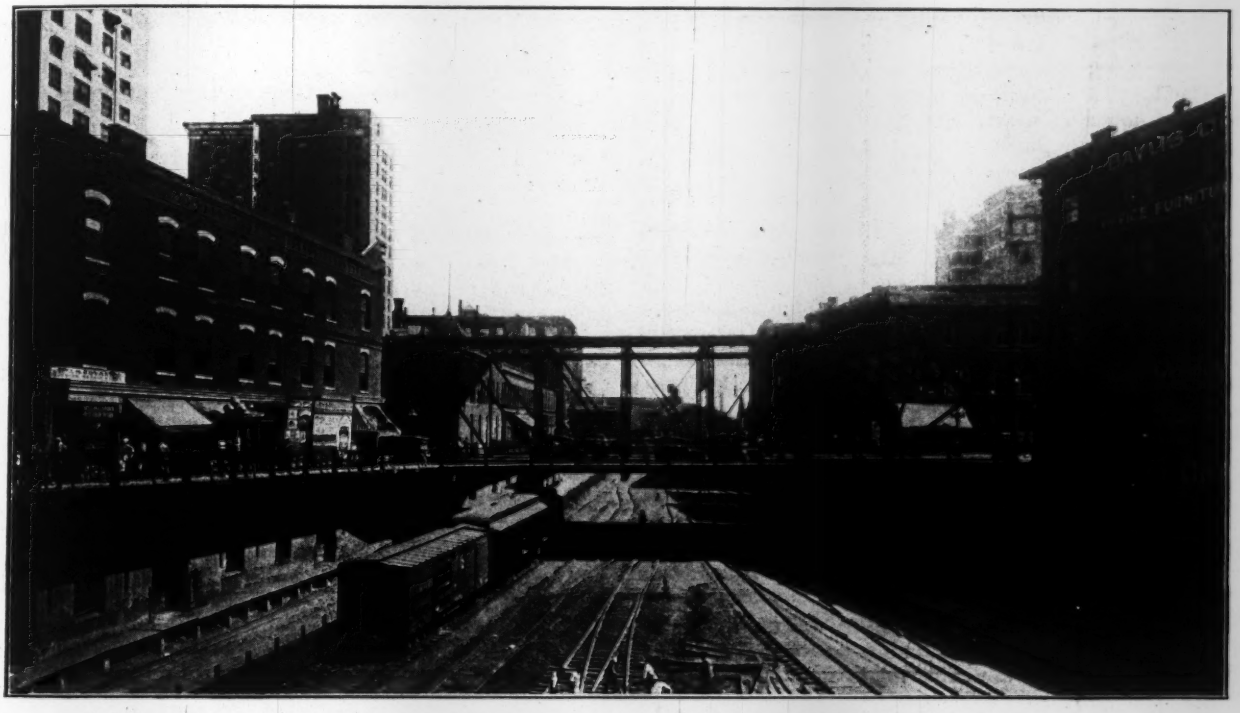
New Railway Terminals Planned for Atlanta, Ga.

An investigation of the railway terminal facilities of Atlanta has recently been made for the city officials of Atlanta by the firm of Barclay Parsons & Klapp, of New York City, and radical changes have been recommended. There are at present two passenger stations in Atlanta, half a mile apart, one called the Union Station, built in 1871, the other known as the Terminal Station, built in 1904. The older station has only four tracks, and the site is too small to permit enlargement. The Terminal Station has already reached about the limit of its capacity. Freight yards used by several of the railway lines are located in the heart of the city, where their operation is a detriment to surrounding property.

The plan for remodeling these terminal facilities worked out by Barclay Parsons & Klapp contemplates the adoption of electric motive power to haul all trains moved within an area probably a mile in diameter, but the engineers believe that the cost of such electrification would be prohibitive.

In the plan recommended by the engineers it is proposed to bring trains under the proposed parks to the new passenger terminal through single-track tunnels. With this method of operation it would be practicable to secure good ventilation, since the air moves with the train.

The estimate of cost for carrying out the entire project is $6,500,000. This estimate includes the cost of purchasing the present Terminal Station, all the necessary land, the construction of the tunnels, the filling in of the ground, the development of the plaza as a park and the removal of the present station to a site about 90 ft. east of its present location. It also includes the money necessary to create new team tracks and freight depots to take the place of those abandoned in carrying out the project.



RAILWAY TRACKS AND YARDS IN ATLANTA BUSINESS DISTRICT
View taken from Forsyth St. Bridge looking east toward old Union Station

the present passenger stations and the co[illegible] a new terminal station for the use of all railwa[illegible]ering the city, on a site capable of enlargement s[illegible]t will be adequate for the city's needs for at least 50 [illegible]5 years to come. It is proposed to abandon the present freight yards in the heart of the city and build new yards in locations convenient for the manufacturing and wholesale districts. The old freight yards will be filled in and converted into parks.

Previous plans have been discussed in Atlanta for removing the nuisance attendant upon the present freight and passenger yards by covering the tracks with a concrete roof and creating a park upon this roof. In commenting on this proposed plan, the engineers point out that it would be practically impossible properly to ventilate the space beneath such a roof, so long as the railways use steam locomotives. This difficulty would be overcome by the adoption of electric motive power to haul all trains moved within an area probably a mile in diameter, but the engineers believe that the cost of such electrification would be prohibitive.

To finance this work it is recommended that the city issue 50-year bonds to cover the cost and that the railways agree to rent the new terminal facilities for an amount sufficient to pay the interest on the bonds and sinking-fund contributions sufficient to retire them at maturity.

Low-Priced Asphalt Pavements—According to Eric Wold, City Engineer of Burlingame, Calif., in an article in the July issue of "Western Engineering," recent prices for pavements of 1½ in. of asphaltic-concrete surfacing (Topeka specifications) on a 4-in. cement-concrete base, are remarkably low this year. A contract was let to the Federal Construction Co., San Francisco, for 181,000 sq.yd. of this pavement for 78c. per sq.yd. The contract included storm sewers, sanitary sewers, curbing, etc., amounting in all to nearly a quarter of a million dollars. The prices of materials were as follows: Cement delivered on the street $2.10 per bbl., crushed gravel $1 per ton, asphalt at the plant in tank-car lots $8 per ton, limestone dust $5 per ton. Keen competition and efficiency in handling materials as well as the size of the job are said to be instrumental in producing the low prices.

New Winnipeg Aqueduct Cracks from Foundation Settlement

SYNOPSIS—A Board of Engineers has just made a report on the cracks which have formed in the new hundred-mile concrete aqueduct which is being built by the City of Winnipeg. The Board finds the cracks to be due to settlement of the aqueduct in sections where it was founded on compressible soil. The method of repairing the cracked sections is described and the plan adopted for obviating similar trouble on the sections of the aqueduct built this season. Notwithstanding the additional expense involved in repairing the cracked sections and in strengthening other portions of the work, the entire project will be carried to completion within the engineer's original estimate of cost.

The City of Winnipeg, Manitoba, is constructing a concrete aqueduct nearly 100 mi. in length to bring a supply of nearly 100,000,000 gal. a day from the Lake-of-the-Woods. A general description of the work was given in *Engineering News* of Feb. 4, 1915, p. 230. About 15 mi. of this aqueduct was completed last year and after its completion cracking occurred on considerable portions.

On Feb. 25, 1916, the Board of Commissioners in charge of the construction of the aqueduct, after receiving a report on the cracking from their consulting engineer, James H. Fuertes, and chief engineer, W. G. Chace, requested a board of engineers consisting of Col. H. N. Ruttan of Winnipeg, J. G. Sullivan of Winnipeg, and R. S. Lea of Montreal, to investigate the whole matter of defects in the aqueduct and report to the commission. This board of engineers on Sept. 26 presented its report to the commission.

For a great portion of its length the new aqueduct is built on the hydraulic grade line and is of horse-shoe shape. At certain river crossings, the aqueduct is of circular form to stand internal pressure. The horse-shoe shaped sections are intended to flow only partially full. The aqueduct is of the cut-and-cover type, and the standard depth of cover specified is 4 ft. over the top of the arch. The minimum top width of the embankment is 8 ft. with side slopes of 1¾ : 1.

The dimensions of the aqueduct vary on different sections according to the slope. There are ten different standard sizes, the smallest being 5 ft. 4¾ in. high and 6 ft. 4¾ in. wide, and the largest 9 ft. high and 10 ft. 9 in. wide. The principal defects have occurred in a section in which the aqueduct is built with a slope of 1.58 ft. per mi. and is 7 ft. 4⅝ in. by 8 ft. 9 in.

Cracks Appear in the Invert

The defects which have developed in the construction in some of the sections of the aqueduct since their completion last season consist of cracks, nearly all of them in the invert. Out of 65,390 ft. of aqueduct completed last year, invert cracks have developed in about 14,380 ft. There is usually a single crack along the middle of the invert; but in a few cases where badly cracked sections occur, there are cracks in the sidewalls of the arch as well.

These cracks have been closely watched since their first appearance by the use of "tell-tales" consisting of smooth pats of cement troweled across the crack. The last sign of movement was observed at the beginning of April. In 4,850 ft. of aqueduct the cracks are from $\frac{1}{16}$ in. to ¼ in. width. About 4,000 ft. have cracks of $\frac{1}{64}$ to $\frac{1}{16}$ in. width, and the remainder has merely hair cracks only discoverable by very careful examination. In some arches where the invert cracks are wide, corresponding cracks have occurred on the crown of the arch. With the exception of a few cracks which are traced to temperature changes, careless backfilling, accidents in removing forms, etc., all the cracks are believed to be due to settlement of the invert.

Design and Construction of the Aqueduct

The aqueduct is built of concrete in the proportions of 1 : 2 : 4, of first-class materials, carefully selected and graded to form a strong and dense mixture. The invert is laid in alternate lengths of 15 ft., connected by a copper expansion joint. The arch is built in alternate lengths of 45 ft. with expansion joints of the same kind. The lengths of both invert and arch are built alternately and an entire length is poured in one operation. The inverts are first laid down for a considerable distance and then the arch is built upon them, the horizontal joints between the invert and the sidewalls being provided with an effective water stop. Steel forms are used in the construction and the interior surface produced is very smooth, while the concrete work in general is of high quality.

The Board of Engineers discuss separately the design of the arch and the design of the invert. Backfilling over the arch is limited to 4 ft. in depth, even in deep cuts. Besides this, before backfilling begins, all standing water, loose materials, débris, etc., are removed and the backfill for a depth of 4 ft. above the arch is required to be of selected earth deposited in layers and solidly rammed. Under these conditions the load on the arch is very small compared with the load carried by similar arches used in railway culverts, large sewers, etc. The board has examined many miles of the arch constructed in 1915 and concludes that where cracks have occurred in the aqueduct arch, they are in no case due to any fault in the design of the arch.

Turning to the design of the invert, the board says that the invert is built in a single monolith of good concrete and has a minimum thickness even in the smallest sizes of 6 in. at the center. The weight of the arch and its covering rests wholly upon the sides of the invert. The board continues:

If we disregard the considerable effect of such an invert in distributing the load, the outer ends only may be looked upon as constituting the footings of the sidewalls. If the effective area of the footings is not sufficient for the bearing power of the soil, or if the trench bottom is carelessly or improperly prepared for the reception of the concrete, undue settlement of the sidewalls relatively to the middle is likely to take place, which will cause the invert to crack, usually along the center line. The effective bearing area of the footings may be increased by extending the invert and increasing its thickness by spreading the outside forms at the bottom of the

sidewalls of the arch, or the entire invert may be utilized to distribute the load by sufficiently increasing its thickness and reinforcing it with steel.

The trench excavation in which the aqueduct is being built is made in all sorts of materials, including clays of varying degrees of compactness, quicksand, soft muck, and muskeg. Clauses in the specifications provide for the securing of good foundations where soft material is encountered.

The section on which the greatest number of cracks have occurred at mile 23 is in a shallow cut, generally between 1½ to 4 ft. depth. This work is in a prairie section and in a clay soil, the bearing power of which has proved to be much less than was anticipated. The resulting settlement has caused the cracking of the invert.

By way of experiment three arch lengths were underpinned with sand driven through holes in the invert close to the sidewalls before sufficient settlement had taken place to form cracks. These inverts have since stood without cracking, but the practice has not been continued.

Cracks which have occurred on other sections of the aqueduct can be traced generally to patches of soft ground permitting settlement of the structure.

Repairing the Damaged Sections

Among the series of questions propounded to the Board of Engineers was the following:

Can the damaged work be repaired to be efficient or will it have to be removed? If it can be repaired, explain how.

The board replies that the damaged work can be repaired to be as permanent and efficient as other portions of the aqueduct, and that none of the work so far built will have to be removed.

The method of repair now being carried out is to cut out the crack to a depth of 1½ to 2 in. and to a width of about 1 in. This groove as far as possible is made wider at the bottom than at the top and never V-shaped. It is carefully cleaned with water, then packed with neat cement slightly moistened, which is hammered solidly into place using a special calking tool. This makes not only an exceedingly tight joint but a very strong one. Tests of portions of the invert including these joints, have shown that even after the cement filling has been in place only two or three days, it adheres so strongly to the concrete that when broken the break has generally been in the old concrete.

Testing the Aqueduct for Leakage

In order to test the efficiency of this repair work, two sections of aqueduct, each about 270 ft. in length, and purposely selected to include the most seriously damaged portion of the work done last year, were repaired in this way in July, 1916. Water-tight bulkheads were built at each end of the section and the aqueduct was filled with water to the level of the usual flow line. Daily records have been kept since then of the loss of water as indicated by the fall of level and are still being continued.

The results so far are very satisfactory. The total loss at the present time is only about 250 gal. per day from each section, each of which has between 200 and 300 lin.ft. of expansion joint below water level. This loss of water is equivalent to less than 5,000 gal. per mile of aqueduct per day, which is much less than the limit usually specified in large concrete pipes under low head. Tests made in April, 1915, in Philadelphia on 36-in. reinforced-concrete pipe under 5 lb. per sq.in. pressure gave a leakage varying from 8,000 to 16,000 gal. per mile per day. The entire cost for the repair work above described on the sections where the cracks are most serious amounts to about 93c. per lin.ft. of aqueduct.

Since no further cracking has taken place since April, it is believed that on the sections where the settlement has occurred the aqueduct has come to firm bearing and that no further defects need be anticipated.

Strengthening the Invert

At an early period in the work of the board it was requested to advise concerning the type of section to be adopted in the work carried on in 1916 to secure safety against future cracking. On May 5, 1916, the board recommended that in firm soil the base of the invert should be extended on both sides to a length of 8 in. beyond the sidewall; and that in compressible soils the inverts should be heavily reinforced. In all the work laid in 1916 these recommendations have been followed, and on about 15 mi. of aqueduct completed, the greater part of which has been backfilled, no settlement cracks have developed.

The results of further studies and tests made by the board, including examinations of twelve 200-ft. lengths of aqueduct at different points along the line, on different foundations, indicate that the inverts recommended in May are stronger than is necessary. The reinforced type of invert distributes the load over the entire width of the foundation and reduces the unit pressure to so low an amount that the 8-in. extensions are unnecessary.

Effect of Repairs and Changes on the Cost

The board is still continuing its experiments, and believes that further modifications may be made in the design which will reduce the cost. If the heavy inverts now in use were to be continued without any modifications in the design except the omission of the side extensions to the reinforced invert, the total increase in cost would be about half a million dollars. The design of the reinforced-concrete invert is based on unit stresses of 10,000 lb. per sq.in. of steel, and 500 lb. per sq.in. compression in the concrete, with liberal assumptions as to the distribution of the load. It is probable that by somewhat lightening the reinforcement where the nature of the foundation will permit it, the additional cost can be considerably reduced.

The original estimate of cost for the entire aqueduct was $7,097,640. The revised estimate at the present time, including the cost of building the inverts on the present expensive plan, amounts to $6,867,700. The aqueduct will be completed, therefore, under the modified design without exceeding the original estimate.

Increasing Use of Vertical-Fiber Brick—Paving work in the towns and villages of Kansas, Oklahoma, Texas, Missouri and Nebraska has continued in increased amounts during the year. Over 1,500,000 sq.yd. of vertical-fiber paving brick have been contracted for by the brick plants in Western Paving Brick Manufacturers Association to towns and cities in the Central West during the season of 1916. Less than 10% of the product of these plants was in the form of repressed paving blocks. Vertical-fiber paving brick are wire-cut brick with bar lugs formed on the clay column by the die. They are laid with the wire-cut surface uppermost and in the majority of cases the joints are filled with asphalt. They are made in depths of 2½ to 4 in. but a large majority of this year's shipments have been brick of 3-in. depth, the recommended standard for towns.

Bridge Wrecked by Runaway Car Derailed at Curve

At 5:20 p.m. on Oct. 3, 1916, a southbound street car loaded with people returning home after the day's work ran away on the steep down grade of West Third St., Cleveland, Ohio, jumped the track at a sharp curve at the foot of the grade just at the entrance to a bridge over the B. & O. Ry. tracks, and demolished the bridge, as shown by the three photographs herewith. A northbound street car crossing the bridge was carried along in the fall (Fig. 1). Two people were killed and about 70 were injured. The motorman of the runaway car left the car before the wreck occurred; his conductor, trying to stop the car, was killed.

The grades on the hill approaching the bridge range from 3% to 9%, as follows: Champlain St. (top of hill) to Prospect Ave., 270 ft., 5.68% grade; across Prospect Ave., 49.5 ft., 3.33% grade; Prospect Ave. to north line of Canal Road, 347 ft., 8.93%; Canal Road to bridge, 139 ft., 7.19%. It is not known just at what point on this grade the motorman lost control of the car. The car had air brakes and hand brakes, and could also have been checked by the motors. At the foot of the grade the car tracks deflect about 30° to the right and enter on the north approach span of the first Cuyahoga River bridge,[1] a 105-ft. through truss span over the B. & O. tracks. This span was built in the spring of 1889, and was of iron. The truss depth was 20 ft., the panel length 15 ft., and the weight of the span 128 tons. The outline sketch shows its general proportions and the position of the two cars that were on the span, Car 369 being the runaway car. The speed of the runaway car when it struck the curve has been estimated as about 40 mi. per hour. The curve at the foot of the grade is short but its degree of curvature could not be learned. There were about 100 passengers on the car at the time of the accident.

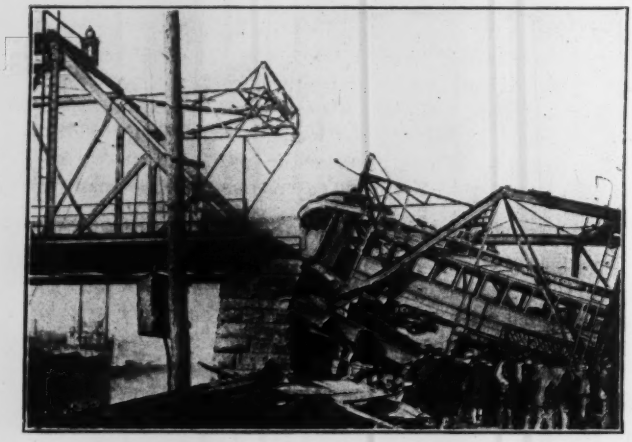


FIG. 1. SOUTH END OF WEST THIRD ST. BRIDGE

At the curve the car left the track to the outside of the curve, crossed over to the northbound track, and shortly after entering on the bridge struck the left-hand or east truss. According to F. D. Richards, bridge engineer of the City of Cleveland, it struck Post 4 a glancing blow, bent it badly, and knocked it out. Then it struck squarely against Post 5 and broke it in two at a point about 4 ft. above the bridge floor. The counters were knocked out at the same time, and the floor laterals were broken. The car ran on to within 5 ft. of Car 378, northbound, which had come to a full stop. Contrary to early reports, the cars did not collide.

The Baltimore & Ohio Ry. was completely blocked by the fall of the span. Mayor Davis refused to allow the railway forces to start removing the wreck until about

FIG. 2. WEST THIRD ST. BRIDGE, CLEVELAND; NEAR VIEW OF POINT OF FAILURE, FROM NORTH ABUTMENT; RUNAWAY CAR IN FOREGROUND

[1] In the flood of 1912 the swing span of this bridge was carried away by a freight steamer that had torn adrift. It was replaced by a second-hand span bought in Detroit. As the views show, the present accident did not involve the swing span in any way.

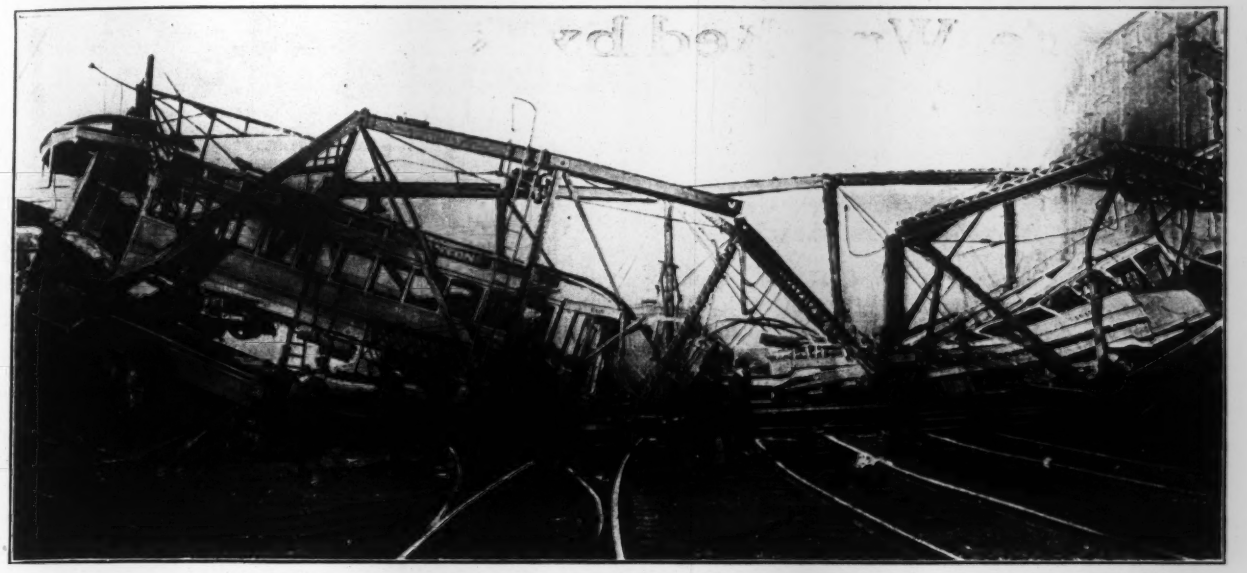


FIG. 3. VIEW OF WEST THIRD ST. BRIDGE FROM EAST. AT RIGHT THE RUNAWAY CAR THAT WRECKED BRIDGE

eight o-clock the next morning. In the meantime investigations were made by A. J. Himes, engineer of grade elimination of the Nickel Plate, and Henry E. Mertens, chief engineer of the Osborne Engineering Co., for the city, and Wilbur J. Watson, and Wm. J. Carter, consulting engineers, for the street railway company. Starting work in the morning, the B. & O. got the tracks open by noon, or in about 4 hr. work. The truss members were cut through by oxyacetylene burners and wrecking cranes hoisted them out of the way. One of the pictures shows the hook of the wrecking crane attached to the end post. This track-clearing was a remarkably fast job. The grade and curve which are directly responsible for this accident have existed for many years, forming a combination that was likely to produce a bad wreck at some time or other. There is no knowledge of a prior accident of this kind at the same point however. Apparently the necessary element, a runaway car, has been lacking.

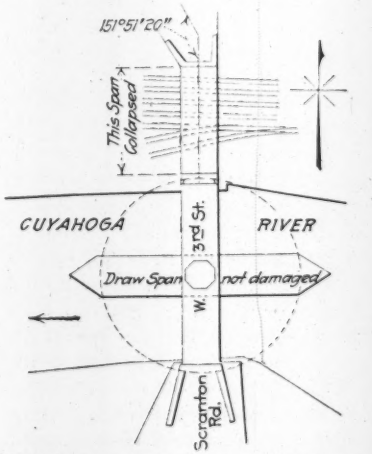


FIG. 4. LOCATION PLAN OF BRIDGE

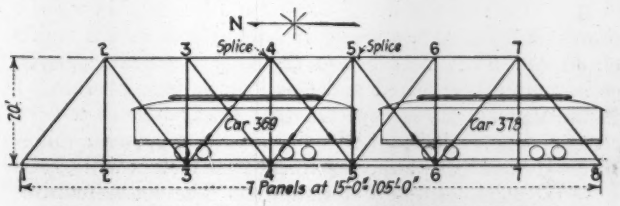


FIG. 5. TRUSS DIAGRAM OF WRECKED BRIDGE
North end at left; position is the reverse of that represented by the view Fig. 3

On Thursday, Oct. 5, the City Council voted $50,000 for restoration of the bridge. On Oct. 6 contract was awarded to the King Bridge Co. for a new superstructure to cost $25,000 and other items of repair and reconstruction including work on the abutments to cost $5,000. It will be at least a month before the new bridge is in place and ready to be opened.

For most of the above figures and specific data *Engineering News* is indebted to F. D. Richards, Bridge Engineer for the city.

Cleveland Limits Loads and Speed of Motor Trucks

Ordinances providing for traffic regulation and the use of streets and sidewalks in Cleveland, Ohio, are specifically worded to guard against damage to pavements, such as that described elsewhere in this issue on West 42nd St., New York City. This is perhaps the only American city where such an ordinance is in effect. It has been in force since May 5, 1916. The following are the clauses in point:

Section 1343-b—(Speed of Motor Trucks)—A motor truck is a motor vehicle with solid tires and constructed to carry freight or merchandise. The speed of motor trucks upon the streets of the city shall not exceed 12 mi. per hr. in cases where the weight of the vehicle and the load is more than 3 tons and less than 8 tons, and shall not exceed 8 mi. per hr. in cases where the weight of the vehicle and the load is 8 tons or more.

Section 1343-e—No load in excess of 12 tons in weight, including the weight of the vehicle, shall be propelled or driven upon or over the streets of the city, provided, however, that the director of public service may issue permits in special cases for the carrying of heavier loads upon or over certain streets specially designated in the permit. Vehicles weighing more than 6 tons, inclusive of the weight of the vehicle, shall not be driven on or over the streets of the City of Cleveland unless there is conspicuously displayed on both sides of the outside of the vehicle in words and figures not less than 2 in. square the weight of the vehicle and the maximum carrying capacity thereof. Nothing herein contained shall be construed to prohibit the hauling of more than 12 tons in a train made up of a power vehicle and trailers, provided, however, that the number of vehicles in such train shall not be greater than is sufficient to haul three separate loads and that the weight of each load, including the vehicle, shall not exceed 12 tons. A train of such vehicles shall carry a brakeman on the rear vehicle.

News of the Engineering World

Additional Claims of Turner Patent Called Invalid

In the United States District Court, Fourth Division, of the Minnesota District, Judge Booth, on Oct. 4, 1916, handed down a decision against C. A. P. Turner, of Minneapolis, who was suing the Deere & Webber Co. for infringement of Turner's patent No. 985,119 in the construction of the flat-slab reinforced-concrete floors of the Deere & Webber building at Chicago. Claims 1, 4 and 6 of this patent were before the same court in the case of Turner vs. Moore & Scriver (*Engineering News*, Apr. 18, 1912, p. 750, Feb. 5, 1914, p. 329). In that case Judge Willard held that the elements in the claim were allowed but that the bringing of them together was not invention and further that the claims were void for lack of invention, in view of the prior art.

In the Deere & Webber case, Mr. Turner introduced Claims 2 and 8 in addition to Claims 1, 4 and 6. Judge Booth decided that there was nothing involved in the two new claims distinct from the original three and that all were subject to the same ruling as applied to the former suit.

The National Research Council

For several months plans have been under discussion for coöperation between the engineering profession as represented by the national engineering societies and the scientific men of the country represented by the National Academy of Sciences. The National Academy was chartered by Congress during the Civil War, with the idea of enabling the Government to obtain the counsel of leaders in the world of science. By the terms of the Academy's charter, the Government has the right to call upon the Academy when it desires advice in scientific matters. Little use has been made of this privilege until recently, when President Wilson sought the aid of the Academy in organizing a commission to study the slides on the Panama Canal. More recently still the advice of the Academy has been sought in the selection of a process of nitrate manufacture to be adopted in the projected Government plant.

The membership of the Academy is confined to scientists who have to their credit some important piece of original work either in scientific investigation or in authorship. The members, therefore, are for the most part confined to the field of pure science, so called; and in both these cases where the aid of the Academy was sought by the Government it was necessary to add to the membership of the commission to be appointed, men selected from the engineering profession.

Realizing the need of coöperative action if the Academy is to fulfill its object of official adviser to the Government, the officers of the Academy have been working with a committee representing the principal national engineering societies, endeavoring to work out some plan by which those devoted to scientific theory and those dealing with applied science could coöperate for the public welfare. The plan decided upon is the organization of the National Research Council, made up of representative men connected with each of the national engineering societies, the heads of such governmental scientific bureaus as deal especially with scientific matters, and a number of other eminent scientists of national reputation.

While a definite charter and constitution for the Council are yet to be formulated, the general purpose is to foster coöperation among present research organizations in the Government departments, in educational institutions and in industrial plants. The chairman of the Council is Dr. George E. Hale, Director of the Mount Wilson Solar Observatory.

An arrangement has been concluded between the National Academy of Sciences and the Engineering Foundation under which the latter has placed its funds at the disposal of the National Research Council for one year and has given the services of its secretary, Dr. Cary T. Hutchinson, to the Council to serve as its secretary.

The Council is made up of 35 members. The American Society of Civil Engineers is represented on it by Clemens Herschel, president of the society; the American Society of Mechanical Engineers by Dr. John A. Brashear, Ambrose Swasey and W. F. M. Goss, past-presidents; the American Institute of Mining Engineers by Charles F. Rand, past-president; the American Institute of Electrical Engineers by John J. Carty and Gano Dunn, past-presidents, Elihu Thomson, C. E. Skinner and W. R. Whitney. It is announced that other members of the Council may be appointed from time to time.

In addition to and independent of this plan for organization already carried into effect, the National Academy of Sciences, in conference with leading engineers representing the different national societies, is canvassing a plan for an organization of larger scope and of larger membership than the National Research Council, still confined, however, to the leaders of the profession in any and all its branches. A committee is investigating plans for such an organization, but it is still undetermined to what extent the organization will be a merely honorary body, membership in which will be conferred as a mark of distinction, and to what extent it will be a working body with definite aims and purposes.

Water Meters for Philadelphia

Meters for all water consumers in Philadelphia will be the practice in a few years, it is expected, as the result of an ordinance now before the City Councils. Large consumers are required and small consumers encouraged to use meters. It is expected that the ordinance will be enacted soon, as it is not only practically unopposed, but is believed to reflect public sentiment that meters will be the only salvation of the water-supply. The main features and effect of the ordinance have been summarized for

Engineering News by Carleton E. Davis, chief of the Bureau of Water, as follows:

All large consumers of water, such as manufacturing establishments, business houses, hotels, saloons, breweries, railroads, etc., must be supplied through meters by Jan. 1, 1918. One year is given for the change, as it is recognized that after the passage of the ordinance the time will be too short to make the change effective on the first of January next.

The present meter rate of 30c. per 1,000 cu.ft. will be increased, the charge for water being 40c. per 1,000 cu.ft. Minimums are fixed for each size of connection, and these minimums carry with them a certain allowance of water without additional charge. In effect this will result in charging the ordinary householder $1 per 1,000 cu.ft., while the largest consumer will receive his water as low as 43c. per 1,000 cu.ft. Between these extremes the charges will vary, depending upon the use of water.

The minimums fixed include a proportional contribution for each service-pipe connection to the interest and sinking-fund charges for outstanding water-works bonds. Such charges amount to about $2,000,000. The minimum charges for each size of service-pipe connection were arrived at by adding to the interest and sinking-fund contribution a certain quantity of water at 40c. per 1,000 cu.ft. The reasons for combining these two factors in a minimum charge were manifold, but were believed to apply with particular force to Philadelphia conditions. While all large users of water will be put on a compulsory meter basis by the first of January, 1918, an inducement is held out to all small users of water to change voluntarily, in that there is a possible saving to the householder by the introduction of a meter of from $1 to $8 or $10 a year.

It is the expectation that in the course of 10 years practically all domestic users will install meters. Some of these installations will be voluntary; some will be compulsory, as the director is empowered to place meters on all premises where waste is permitted.

A proposition to compel all new connections to the mains after Jan. 1, 1917, to be placed on meters was discussed, but considered inadvisable at this time, it being believed that it was better to have the consumer voluntarily place a meter because of the inducement in the rates.

The financial condition of the city made it necessary to have meters placed at the expense of the consumer. While it would be better for the city to own as well as control all meters, it is impossible at the present time. In two years it may be practicable to work out this situation.

Engineers Inspect Brick Paving

A demonstration of the new method of brick paving (for streets and country roads), in which the brick is laid directly upon the green concrete, was a feature of the 13th annual meeting of the National Paving Brick Manufacturers' Association.

The meeting proper was held at the Deming Hotel, Terre Haute, Ind., on Oct. 5, but was of a business or commercial rather than a technical character. In the evening, however, there was a display of moving pictures showing the construction of brick and macadam roads, including the new automobile highway for the ascent of Pikes Peak, Colorado. In all about 250 people were present, including a large number of visitors (engineers, municipal officers, highway superintendents, etc.) specially invited to see the paving work in progress. The officers elected are as follows: President, C. C. Blair, Cleveland, Ohio; Vice-President, J. W. Robb, Clinton, Ind.; Secretary, W. P. Blair, Cleveland, Ohio.

On Aug. 6, the party was taken in automobiles over some of the notable brick-paved streets of Terre Haute. These included a paving 25-yr. old, of brick on broken stone base, with sand cushion and cement filler. Other paving included concrete with and without a bituminous top. Special interurban cars then took the party for a trip to Paris, Ill., where street cars were provided to carry them to the demonstration point, at which brick paving was in progress on a country highway. The inspection of this work was followed by lunch at the water-works park, after which automobiles took the visitors for a ride over several country roads having brick and gravel paving.

In the paving work under demonstration, the subgrade was rolled, with a tandem roller, and steel side forms were set (oiled to adhere to the concrete). The concrete was dumped upon it from a tilting bucket on the boom of a steam-operated mixer; it was tamped against the side forms and roughly leveled by a steel plate with chains drawn by men. Behind this came a steel templet carried by rollers traveling on steel forms. This consisted of two parallel transverse beams, braced together, and between these was filled a dry mixture of sand and cement, 2:3. The mixer hauled this templet forward by means of chains, and the wire-cut-lug brick were at once laid on the smooth surface of the dry mix.

After inspection and culling, the surface was rolled by a one-man hand roller, and then sprinkled. The first application of cement grout was quite wet, and was poured directly by a long spout on a grout mixer, being then broomed into place. For the second application, the grout was made thicker (of a soupy consistency), and delivered into wheelbarrows from which it was dumped upon the surface. This mixture was carefully spread and worked with squeegees for some time, thoroughly filling the joints and leaving quite a heavy coat of grout upon the surface. This completes the paving, which is then left for at least 15 days before being opened to traffic.

Flood Prevention at Olean

Joint appropriations of city and state and contributions of citizens provided the funds for the $500,000 flood prevention project now under way at Olean, N. Y., on the line of the Allegheny River and Olean Creek. Floods in the lowlands of the city have been destructive and dangerous for many years and in 1913 concerted action by a number of citizens resulted in the introduction into the State Legislature of a bill appropriating $150,000 by the state for flood prevention work provided the city raised a like sum. This bill became a law in 1915 and the local appropriation was carried at the next election by a vote of 6 to 1. In addition about $200,000 worth of land was donated by citizens.

Under the statute a Flood Abatement Commission came into existence and O'Connor & Chapman, of Albany, N. Y., were employed as executive engineers. They prepared plans, subject to the approval by the Superintendent of Public Works, and early in 1916 a contract was let to the James M. Hamilton Contracting Co. to do the work. Construction is now about one-third completed.

The plans comprise the straightening, widening and deepening of channels in river and creek and the building of an 8½ mi. earth dike or levee along the widened channels. Electrically driven pumps will take care of sewage and lateral streams in flood time. Within the city limits Olean Creek is to be materially revised as to line. At present it meanders over a large area which it overflows at intervals. The new scheme replaces the many curves by one easy, long curve and widens the channel to a safe cross-section. In the land left by the straightening a number of city parks will be laid out.

Jacksonville Municipal Docks Are Open for Business

The new municipal docks at Jacksonville, Fla., have just been made ready for business. These docks have been under construction for about two years. They were built after the city voted to authorize the issue of bonds to the amount of $1,500,000 "for the purpose of acquiring site and constructing docks, belt line, cotton and merchandise warehouses, compresses," etc. The site is located about 3.7 mi. from the city hall on the St. John River, with full riparian rights to the 30-ft. channel now being dredged by the Federal Government, having now a minimum depth of 26 ft. One mile of water frontage was secured.

At the present time there is docking space for fourteen average-size freight steamers, with a three-quarters of a square mile 30-ft. depth anchorage in front of the dock. Two piers, each 1,000 ft. in length by 260 ft. in width have been built. One is an open pier for handling lumber, rosin, turpentine, tars, and other commodities not injured by the weather; the other has two immense steel warehouses 800 ft. long by 73 ft. wide. Both piers are timber extensions outside of fill, and are paved with vitrified brick set in cement. They are connected by railroad tracks to the municipal belt railroad.

There are in addition reinforced-concrete warehouses back from the pier but on the railroad, in which are installed two cotton compresses; one, the latest model "Standard" compress, which produces a rectangular bale with a density of 32 lb. per cu.ft. and contains about 16 cu.ft., somewhat smaller than the ordinary cotton bale. This reduced bulk saves in shipping rates. The piers and the warehouses are all protected against fire with fire-fighting appliances and fire pumps supplied with water from artesian wells and a reservoir on the property. Some of the details of the construction of the work were published in *Engineering News*, Dec. 2, 1915, page 1099.

The International Correspondence Schools, of Scranton, Penn., celebrated their twenty-fifth anniversary on Monday, Oct. 2. Exercises were held in the afternoon at the Strand Theater in Scranton, and in the evening a banquet was given in the Educational Building of the schools, at which the guest of honor was Governor Brumbaugh of Pennsylvania.

A Transit Commissioner for Pittsburgh is proposed in an ordinance just passed by the Council of the city. The bill provides that the mayor appoint a transit commissioner at a salary of $8,000 a year, the appointment to be subject to the approval of the Council, and requests that the commissioner as soon as possible after appointment prepare a budget showing the number of engineers, draftsmen, etc., needed.

The Joseph A. Holmes Safety Association has been organized to establish a permanent memorial to the late Dr. Joseph A. Holmes, Director of the Bureau of Mines. Dr. Holmes' great achievement, in the work to which the later years of his life were devoted, was the safeguarding of those engaged in the mining industry. It is proposed therefore that the memorial to him shall take the form of an endowment fund, the income from which shall be devoted annually to the award of one or more medals with honorariums, to be known as the Holmes' award, for the encouragement of those originating, developing and installing the most efficient safety devices, appliances or methods in the mineral industry during the year. Twenty-three prominent scientific and technical organizations are represented in the association, including the American Societies of Mechanical, Mining and Electrical Engineers, the American Society for Testing Materials, the American Chemical Society and several important Government bureaus. The president of the association is Van H. Manning, Director of the Bureau of Mines, and the secretary is Dr. David T. Day, of Washington, D. C. Contributions to the endowment fund are invited from those who knew Dr. Holmes or are interested in the further development of the movement for safety in mining.

PERSONALS

Homer Neal, formerly with the Braden Copper Co., has recently been appointed Engineer in charge of the Central Chile Copper Co. mines in Tambillos, Chile.

H. E. Swock, formerly with the American Steel and Wire Co., Donora, Penn., has been made Chief Draftsman of the Page-Hersey Iron Tube and Lead Co., Welland, Ont.

Thomas Stanley, formerly Engineer of the Georgia State Prison Commission, has been appointed States Highway Engineer, under the recent act creating a State Highway Department.

Joseph A. West, formerly Chief Engineer of the Ogden, Logan & Idaho Ry., has been appointed Chief Engineer of the Sumpter Valley Ry., of Oregon, with headquarters at Baker, Ore.

George Durham, recently Master Mechanic of the Delaware, Lackawanna & Western R.R., at Scranton, Penn., has been appointed Superintendent of Motive Power of the Wheeling & Lake Erie Ry., at Brewster, Ohio.

J. B. Lippincott, M. Am. Soc. C. E., of Los Angeles, Calif., has been made Consulting Engineer of the Automobile Club of Southern California. He is assisting the club in its campaign in favor of a new issue of state-road bonds.

C. F. Messinger, for several years Advertising Manager of the Chain Belt Co., Milwaukee, Wis., has been appointed Manager of the concrete mixer department of the company. He is a graduate of Sheffield Scientific School, Yale University.

Edward T. Bailey, formerly with the Emerson Building Co., New York City, announces that he has become associated with Joseph O'Connor, of New York and Minneapolis, to conduct a general contracting business with offices at 103 Park Ave., New York City.

E. B. Taylor, M. Am. Soc. C. E., Second Vice-President of the Pennsylvania Lines, has been elected President of the Lorain, Ashland & Southern R.R., recently bought by the Pennsylvania. He succeeds the late Joseph Ramsey, builder and owner of the road.

E. P. Peek, Major, Corps of Engineers, U. S. A., in charge of the United States Engineer Office at Duluth, Minn., has been transferred to the office of the Chief of Engineers, Washington, D. C. He is succeeded by Lieutenant-Colonel E. L. Schulz, now at New Orleans, La.

Prof. D. F. Thompson, for 45 years the head of the department of stereotomy and descriptive geometry at Rensselaer Polytechnic Institute, has resigned, and has been appointed Professor Emeritus. He is succeeded as head of the department by Prof. E. F. Chillman.

Edgar A. Van Deusen, for the past four years Chief Draftsman at the New York City office of the Southern Power Co., has been transferred to the company's headquarters at Charlotte, N. C. **Austin H. Reeves,** of the New York office, has been promoted to succeed Mr. Van Deusen.

Harry S. Stanton, Assoc. M. Am. Soc. C. E., now engaged in the completion of the Elephant Butte dam, New Mexico, has resigned from the Reclamation Service and will be associated with E. W. Hess, Engineer, M. Am. Soc. C. E., at Du Bois, Penn., in the general practice of engineering.

Charles Peter Weeks, Architect, and **W. P. Day,** Assoc. M. Am. Soc. C. E., formerly of Leonard & Day, Consulting Engineers, San Francisco, Calif., announce the formation of the firm of Weeks & Day, Phelan Bldg., San Francisco, for the general practice of architecture and engineering.

H. V. Latham, for the past four years Designing Engineer of the Porto Rico Irrigation Service, has been appointed Engineer in charge of irrigation investigations in the districts of Ponce, Juana Diaz, Lajas and Isabela, Department of the Interior, Government of Porto Rico, with offices at Ponce, P. R.

G. W. Stickney, formerly Designing Engineer of the paving department of the Syracuse, N. Y., Bureau of Engineering, has been appointed Chief Engineer of the Rivers and Lakes Commission of Illinois. He is a graduate of the University of Maine, class of 1900, and has had experience with the Metropolitan Water-Works of Boston, Mass., and the New York State Barge Canal.

Clark R. Mandigo, Assoc. M. Am. Soc. C. E., for the past six years Assistant City Engineer of Kansas City, Mo., has resigned to accept a position as Engineer with the Portland Cement Association. He will look after the interests of the Association in Kansas and western Missouri. Over 100 mi. of concrete pavements have been laid under his supervision on streets in Kansas City in the past six years.

P. A. Fellows, a 1906 graduate of the University of Michigan, has been appointed Instructor in the Civil Engineering at his alma mater to succeed J. H. Bringhurst, Assoc. M. Am. Soc. C. E. Mr. Fellows was formerly Assistant Engineer of the Central of Georgia Ry. and later General Superintendent of the Winsboro Granite Corporation of Savannah, Ga. He received a master's degree in civil engineering in 1916.

R. P. Boyd, whose resignation as Assistant State Highway Engineer of Alabama was noted in these columns of Sept. 28, has become associated with James W. Billingsley, Consulting Engineer, New Orleans, La., and will have direct charge of a $500,000 road improvement contract in Ouachita Parish, in Northern Louisiana. He is a graduate of Alabama Polytechnic Institute, and has been Principal Assistant State Highway Engineer of Alabama since 1911.

Dr. Charles H. Fulton, M. Am. Inst. M. E., Professor of Mining and Metallurgy, Case School of Applied Science, Cleveland, Ohio, who discovered a process of recovering zinc from ore by an electric process, has begun a commercial application of the process at St. Louis, where a plant has been built. **Thomas M. Bains,** Instructor in the department of mining engineering, and **R. O. Jackson,** Instructor in the department of mechanical engineering of Case School, will be associated with Dr. Fulton in the new undertaking.

Gen. George W. Goethals, M. Am. Soc. C. E., has been appointed Chairman of the Federal Commission which is to study and report on the effect of the eight-hour railway labor law, recently passed by Congress at the instigation of President Wilson. He has returned to this country from the Panama and, it is reported, will soon resign as Governor of the Canal Zone. The other members of the commission are E. E. Clark, a member of the Interstate Commerce Commission, and George Rublee, a member of the Federal Trade Commission.

George F. Swain, Past-President, Am. Soc. C. E., has been appointed Consulting Engineer of the Canadian Railway Board of Inquiry, which is constituted under the Inquiries Act of Canada to inquire into the railway situation of that country. The members of the board are A. H. Smith, President of the New York Central Lines, Sir Henry Drayton, Chairman of the Dominion Railway Commission, and Sir George Paish, Editor of "The Statist," of London, England. Professor Swain is head of the department of civil engineering at Harvard University and Chairman of the Boston Transit Commission.

OBITUARY

James T. Golden, of the firm of Golden & Crick, general contractors of Pittsburgh, Penn., died Sept. 27, at his home in Wilkinsburg. He was born in 1863.

Jasper H. Sheadle, Vice-President of the Cleveland-Cliffs Iron Co., died Sept. 22, at Syracuse, N. Y. He was prominently identified with the Great Lakes ore trade for the past 22 years.

L. E. Hall, Jr., Inspecting Engineer of the Southern Pacific Ry., died at the Southern Pacific Hospital in San Francisco Sept. 26, as a result of an accident at the site of the railway's new building at Market and Stewart St. He was struck on the head by a piece of timber falling from the top of a pile-driver. He was a nephew of William Hood, M. Am. Soc. C. E., Chief Engineer of the Southern Pacific.

E. M. Butz, of E. M. Butz & Co., Ltd., and widely known throughout the country as an architect and engineer, died on Oct. 4 at his home on the North Side of Pittsburgh. Mr. Butz was born in Allegheny in 1859. He was identified with the construction of some of the finest buildings in western Pennsylvania and had been a pioneer in the steel business and promoter and builder of the Columbia Iron and Steel Co.'s plant at Uniontown, of which for several years he was General Manager. Mr. Butz retired from active business about six years ago.

George M. Anderson, of the firm of Elzner and Anderson, architects, died at his home in Cincinnati, Ohio, Oct. 3. He was a member of the American Institute of Architects and for the past two years president of the Cincinnati Chapter of the Institute. He was a member of the firm which designed the Ingalls Building, at Fourth and Vine St., the construction of which was completed in 1903. This structure has the distinction of being the first modern office building in the world constructed of reinforced concrete, 16 stories in height, or 210 ft. above the street pavement.

Robert Cochran McKinney, M. Am. Soc. M. E., Chairman of the Board of Directors of the Niles-Bement-Pond Co., of New York City, died at his home in Belle Haven, Conn., Oct. 3. He was born in Troy, N. Y., in 1851. Ten years later his parents moved to Cincinnati, where he was educated at the public schools. He took a partial course in mechanical engineering at Cornell University in the early seventies and became a draftsman with a company manufacturing steam pumping machinery at Hamilton, Ohio. In 1877 he became connected with the Niles Tool Works. From that time his talents and engineering ability were devoted to building up the great organization now known the world over as the Niles-Bement-Pond Co., organized 17 years ago. Colonel McKinney was a Past-President of the Machinery Club, New York City, and a member of the Engineers' Club and other organizations.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 9-13. Convention in Newark, N. J. Secy., Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B. Burritt, 8 West 40th St., New York City.

IRRIGATION CONGRESS.
Oct. 14-24. 23rd International Irrigation Congress at El Paso, Tex. Secy., Arthur Hooker, El Paso.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N. W. Ry., Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 24-27. Annual convention at Cincinnati, Ohio. Secy., Prof. Selskar M. Gunn, Boston, Mass.

RAILWAY ELECTRIC SUPPLY MANUFACTURERS' ASSOCIATION.
Oct. 30-Nov. 3. Annual meeting at Chicago. Secy., J. Scribner, General Electric Co., Chicago.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 14. Convention in Washington, D. C. Secy., W. H. Connolly, Washington.

RAILWAY GARDENING ASSOCIATION.
Dec. 5-7. Annual meeting in New Orleans. Secy., Charles E. Lowe, Sewickley, Penn.

PORTLAND CEMENT ASSOCIATION.
Dec. 11-13. Annual meeting in New York City. Assistant to General Manager, A. H. Ogle, Chicago, Ill.

The Municipal Engineers of the City of New York will hold their annual dinner on Nov. 25.

The Richmond Railroad Club will hold its annual meeting in Richmond, Va., on Nov. 13. The secretary is F. O. Robinson.

The Vermont Society of Engineers held its 5th annual fall convention and excursion Oct. 11 and 12, at Rutland and Glens Falls.

The Southern and Southwestern Railway Club will hold its annual meeting on Nov. 16, in Atlanta. The secretary is A. J. Merrill, P. O. Box 1205, Atlanta, Ga.

The American Railway Association will meet on Wednesday, Nov. 15, in Denver, at the Brown Palace Hotel. The general secretary is J. E. Fairbanks, 75 Church St., New York City.

The Society of Naval Architects and Marine Engineers will hold its next annual meeting Nov. 16 and 17, in New York City. The secretary is D. H. Cox, 29 West 39th St., New York City.

The General Contractors Association will hold its annual meeting in New York City on Dec. 9; the election of officers, however, will not take place until January. The secretary is C. A. Crane.

At the American Association of Iron and Steel Electrical Engineers' convention in Chicago, F. D. Egan, of Midland, Penn., was elected president, and J. E. Kelly, of McKeesport, Penn., secretary.

The American Society of Refrigerating Engineers will hold its annual meeting at the Engineering Societies building, New York City, Dec. 4 to 6. The secretary is William H. Ross, 154 Nassau St., New York City.

The Texas Association of Members of the American Society of Civil Engineers, at the annual meeting in Dallas, Oct. 20 and 21, will listen to a report by a special committee on "Proposed Legislation Providing for the Licensing of all Engineers in Texas."

Ohio Society of Mechanical, Electric and Steam Engineers will hold its annual meeting on Thursday, Nov. 16, at Columbus, Ohio. It is planned to print the "Journal" of the

meeting in advance, so that the papers need be given only in brief abstract.

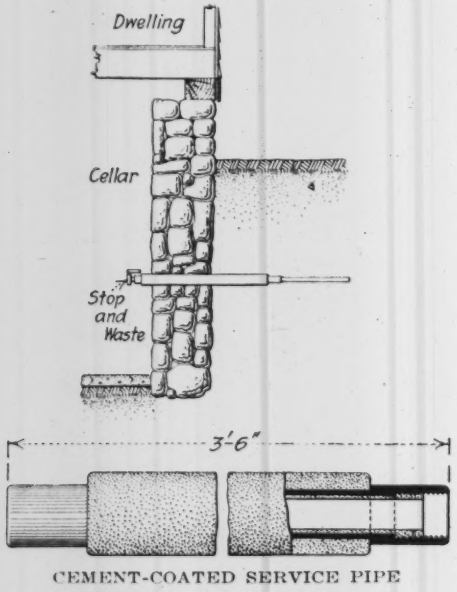
Water-Works Superintendents and Chief Engineers of municipally-owned plants and of electric-light and power plants of towns in Mississippi have formed an association. The organization meeting in Jackson, Miss., was called by Henry Converse, of Crystal Springs.

The Philadelphia Association of Members of the American Society of Civil Engineers, at the annual meeting on Oct. 2 elected the following officers: President, Samuel T. Wagner, vice-president, Edward Marburg, directors, Harrison Louder and Frederick E. Shall, secretary, C. W. Thorn. W. L. Stephenson was selected by the Board of Direction to fill the unexpired term of Colonel Zinn, resigned.

Appliances and Materials

Protected Water-Service Pipes

To meet the difficulties caused by excessive corrosion of water services at the place where they pass through the cellar walls of buildings, the Macbee Cement-Line Pipe Co., of Boston, Mass., has placed on the market a specially protected pipe for this part of the service connection. The device consists of a 3-ft. 6-in. section of cement-lined wrought-iron pipe, with a coupling at each end and with the exterior



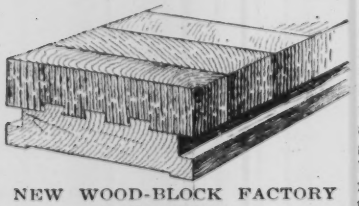
CEMENT-COATED SERVICE PIPE

coated to a depth of about ½ in. with neat cement mortar. The accompanying illustration shows its use. A patent has been applied for. These sections are known by the trade name of "cellar wall services."

* * *

New Wood-Block Factory Flooring

A new type of yellow-pine wood-block flooring, which is shipped and laid in plank lengths, has been patented (Mar. 28, 1916) and placed on the market by the C. J. Carter Lumber Co., Kansas City, Mo. This flooring is the invention of C. J. Carter and has the trade name "Bloxonend." The process of manufacture consists of dovetailing the ends of the blocks to a base board, then smoothing the block surface and dressing and grooving the edges. The base boards are about 8 ft. long. The relative thicknesses of the blocks and the base boards vary,

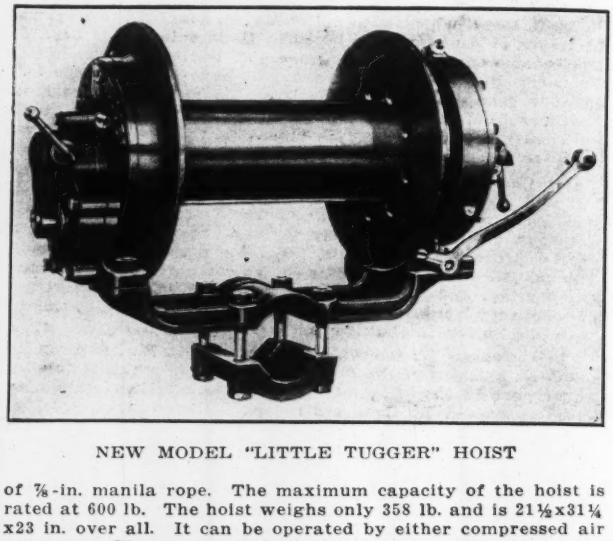


NEW WOOD-BLOCK FACTORY FLOORING

$\frac{1}{2}$ and $\frac{2}{1}$ being the common sizes. The $\frac{2}{1}$ flooring has 2-in. blocks on a 1-in. base. On the surface the blocks are 1½x3½ in. The blocks are placed with the grain vertical and are glued to the base board as well as dovetailed.

New-Model Small Hoist

The Ingersoll-Rand Co., New York City, has placed on the market a new model of its line of "Little Tugger" hoists, known as No. 11. This has a hoisting drum 7 in. in diameter by 17 in. long with 5-in. flanges. The drum handles 300 ft.



NEW MODEL "LITTLE TUGGER" HOIST

of ⅞-in. manila rope. The maximum capacity of the hoist is rated at 600 lb. The hoist weighs only 358 lb. and is 21½x31¼ x23 in. over all. It can be operated by either compressed air or steam. The standard clamp fits a 4½-in. column or pipe, but by removing the clamp the hoist can be readily bolted to any convenient support.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

of Engineering News, published weekly at New York, N. Y., for October 1, 1916.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the State and County aforesaid, personally appeared Chester W. Dibble, who, having been duly sworn according to law, deposes and says that he is the Vice-President of Hill Publishing Co., Publishers of Engineering News, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor and business manager are:

Publisher, Hill Publishing Company, 10th Ave. at 36th St., New York, N. Y.
Editor, Charles Whiting Baker, 10th Ave. at 36th St., New York, N. Y.
Managing Editor, Frank C. Wight, 10th Ave. at 36th St., New York, N. Y.
Business Manager, William Buxman, 10th Ave. at 36th St., New York, N. Y.

2. That the owners are:

Hill Publishing Company, 10th Ave. at 36th St., New York, N. Y.
Owners of 1% or more of Stock Issued.
Estate of John A. Hill, 10th Ave. at 36th St., New York.
Arthur J. Baldwin, 10th Ave. at 36th St., New York.
Fred R. Low, 10th Ave. at 36th St., New York, N. Y.
John McGhie, 10th Ave. at 36th St., New York, N. Y.
Fred S. Weatherby, 1600 Beacon St., Brookline, Mass.
Frederick A. Halsey, 356 W. 120th St., New York, N. Y.
G. Eugene Sly, 50 Union Sq., New York, N. Y.
Frederick W. Gross, 215 E. 11th St., Erie, Penn.
Emma B. Hill, 80 Munn Ave., East Orange, N. J.

The remaining stock is owned by 91 stockholders who own less than 1% each, 73 of whom are employees of the company.

3. That the known bondholders, mortgagees and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages or other securities are: Mortgage on building, Dime Savings Bank, Brooklyn, N. Y.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association or corporation has any interest direct or indirect in the said stock, bonds or other securities than as so stated by him.

CHESTER W. DIBBLE,
Vice-President, Hill Publishing Co.

Sworn to and subscribed before me, this 29th day of September, 1916.

[Seal.] RICHARD L. MURPHY.
(My commission expires March 30, 1917.)